

# **New Hampshire Volunteer River Assessment Program**

**2000**

**COCHECO RIVER**

**Water Quality Report**



February 2003

**STATE OF NEW HAMPSHIRE**  
**Volunteer River Assessment Program**  
**2000**  
**COCHECO RIVER**  
**Water Quality Report**

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# 1. VOLUNTEER RIVER ASSESSMENT PROGRAM OVERVIEW

VRAP (“vee-rap”) supports watershed organizations in their efforts to monitor river water quality. The primary focus of VRAP is to provide volunteers with river monitoring guidelines, equipment loans, and technical training. DES also incorporates applicable volunteer monitoring results into its evaluation of New Hampshire surface waters. Annual reports for each VRAP river include a summary of monitoring results and recommendations for future water quality sampling. VRAP aims to foster public understanding and stewardship of river systems and to increase available water quality information about New Hampshire rivers and streams.

VRAP loans and maintains water monitoring kits that include meters and supplies for on-site measurement of five basic water quality parameters: water temperature, dissolved oxygen, pH, specific conductance (conductivity), and turbidity. The investigation of these and additional parameters such as nutrients, metals, and *E. coli* is conducted by state water quality personnel and may be augmented by volunteer sampling. Sampling additional parameters comes with the cost of analysis, which can be covered by an assortment of fundraising activities such as association membership fees, special events, and in-kind services (non-monetary contributions from individuals and organizations), and grant writing.

Water quality measurements repeated over time create a picture of the fluctuating conditions in rivers and streams and help to determine where improvements, restoration or preservation may benefit the river and the communities it supports. Water quality results are also used to determine if a river is meeting surface water quality standards. Volunteer monitoring results meeting DES Quality Assurance and Quality Control (QA/QC) requirements supplement the efforts of DES to assess the condition of New Hampshire surface waters. The New Hampshire Surface Water Quality Regulations are available through the DES Public Information Center at [www.des.state.nh.us/wmb/Env-Ws1700.pdf](http://www.des.state.nh.us/wmb/Env-Ws1700.pdf) or (603) 271-1975.

VRAP typically recommends sampling every other week during the summer, and citizen monitoring groups are encouraged to organize a long-term sampling program in order to begin to determine trends in river conditions. Each year volunteers arrange a sampling schedule and design in cooperation with the VRAP Coordinator. Project designs are created through a review and discussion of existing water quality information, such as known and perceived problem areas or locations of exceptional water quality. The interests, priorities, and resources of the partnership determine monitoring locations, parameters, and frequency.

Each VRAP volunteer must attend an annual training session to receive a demonstration of monitoring protocols and sampling techniques. Training sessions are an opportunity for volunteers to come together and receive an updated version of monitoring techniques. Training sessions are typically conducted outdoors near surface waters for an interactive demonstration. During the training volunteers have a chance to practice using the VRAP equipment and may also receive instruction in the collection of samples for laboratory

analysis. Training is accomplished in approximately three hours, after which volunteers are certified in the care, calibration, and use of the VRAP equipment.

VRAP groups conduct sampling according to a prearranged monitoring schedule and VRAP protocols. VRAP aims to visit volunteers during scheduled sampling events to verify that volunteers successfully follow the VRAP protocols. If necessary, volunteers are re-trained during the visit, and the group's monitoring coordinator is notified of the result of the verification visit. Volunteer organizations forward water quality results to the VRAP Coordinator for incorporation into an annual report and state water quality assessment activities.

Applicable volunteer data are input to a water quality database, and considered (along with other reliable sources of data) during periodic DES water quality assessments. Assessment results and the methodology used to assess surface waters are published by DES every two years (i.e., Section 305(b) Water Quality Reports) as required by the federal Clean Water Act.

More than fifty VRAP volunteers sampled five rivers regularly during the year 2000. VRAP 2000 rivers include the Lamprey, Exeter, Cocheco, Sugar, and Baker Rivers, as well as preliminary sampling on several additional rivers and streams. These accomplishments were made possible by the hard work and dedication of citizen volunteers and many additional people who helped to plan, support, and carry out these monitoring efforts.

## **2. PROJECT SUMMARY: COCHECO RIVER VRAP 2000**

The Cocheco River Watershed Coalition (Coalition) became interested in exploring water quality in the river system further after preliminary water quality investigations in 1998 with DES Non-point Source (now Watershed Assistance) Section staff. The Strafford Regional Planning Commission submitted a Local Initiative Program grant application to DES and was awarded funding to support a project coordinator and coverage for sampling in addition to the VRAP baseline parameters. The City of Rochester Public Works Department donated in-kind services including analysis for *E. coli* bacteria and an extremely valuable municipal partnership. The Volunteer River Assessment Program provided field training, equipment, and technical assistance.

Three monitoring teams, complete with field leaders, became known as the very dedicated 2000 Cocheco River Watch (CRW). Every other week from May 24<sup>th</sup> through September 20<sup>th</sup>, 2000, volunteers reached the river in the early morning hours to analyze the water for the VRAP baseline parameters and to collect *E. coli* samples for analysis at the Rochester Waste Water Treatment Facility before 10 a.m. Twice during the summer samples were collected for metals analysis conducted at the DES Laboratory Services Unit in Concord. DES Laboratory Services and the UNH Lakes Lay Monitoring Program analyzed biweekly samples for total phosphorus.

Eight sites along the mainstem of the Cocheco River were monitored every other week from its upper limits in Farmington to the tidal dam in Dover (see map and list, Appendix A). The sampling sites selected in 2000 are those previously sampled by the DES Ambient River Monitoring Program and the 1999 CRW project. Potential problem areas throughout the watershed have been identified by the Coalition with guidance from DES staff through group reviews of historical data, recent water quality sampling results, and observations of river conditions. A map of each sampling location is included in the Results and Discussion section of this report.

Data generated by this project will be used in educational outreach for thirteen watershed communities; by interest groups and the general public; for long-term watershed management; and for decision-making by community land use boards and departments of planning and public works. Regionally, the data will be provided to coastal watershed agencies and organizations for use in resource planning. The Project Coordinator, an individual designated as the point of contact for the VRAP Coordinator, presents the VRAP reports to the river group's distribution list (see Appendix A for Cocheco River VRAP 2000 Project Coordinator and volunteer list). DES uses volunteer river data to help assess the quality of surface waters in the State (see Chapter 1).

### **3. RESULTS, DISCUSSION, AND RECOMMENDATIONS**

This section includes a description of the Cocheco River VRAP 2000 monitoring locations and results, a discussion of the results in comparison with New Hampshire water quality standards, and recommendations for future sampling and watershed investigations. The VRAP monitoring locations, "stations", are discussed from upstream to downstream (see watershed map, Appendix B). Each station is described by a map and by a narrative site description submitted by volunteers. Results are presented in graphs and text prepared by the VRAP, and tables including all monitoring results from each site are located in Appendix C. The discussion of the results includes recommendations for future sampling and investigations that will contribute to the assessment of water quality conditions.

The water quality information collected at each station is summarized in a table that provides the reader with an overview of the monitoring activities and results. The table can be used as a quick reference for the reader; results not meeting state water quality criteria do not necessarily indicate a violation of water quality standards. The summary table indicates: (1) the number and type of samples collected, (2) the number of samples collected according to quality assurance and quality control requirements, (3) the number of samples not meeting state water quality criteria, (4) the range of the measurements, and (5) abbreviated water quality standards.

The presentation and discussion of the volunteer results focuses primarily on three parameters: DO, temperature, pH, and *E. coli*. These parameters are the core of the VRAP monitoring system, and have relatively straightforward standards that lend themselves to the assessment of individual results. These results can contribute directly to the determination of fishable and swimmable river and stream conditions, which is

often a primary volunteer monitoring goal. This section includes graphs of dissolved oxygen (DO) concentrations with water temperature, and *E. coli* bacteria results (if collected). Please see Appendix D for descriptions of the water quality parameters analyzed under VRAP during 2000 and the associated New Hampshire surface water quality standards (SWQS) for Class B waters.

The reader should note that discussion is limited to those parameters at each site that do not meet state criteria. For example, since *E. coli* is the only parameter at 26-Cch that exceeded state criteria, only *E. coli* will be discussed in detail. However, recommendations are not limited to parameters with results that fall outside state criteria.

The Coalition chose to carry out preliminary water quality sampling at locations in the watershed in addition to their biweekly monitoring locations. These sampling locations are listed in Appendix B, and the results are located in Appendix C. Conclusive statements about water quality at these locations are not available at this stage.

VRAP aims to provide a mechanism for citizens to contribute to the ongoing process of surface water quality assessment. Recommendations for future monitoring activities and watershed investigations are included in this report following the results and discussion. Also included are recommendations for improvements in sampling techniques to encourage volunteers to adhere to quality assurance and control measures.

Volunteers are encouraged to sample their rivers and streams on a long-term basis. Much of the information volunteers collect profiles river and stream locations for the first time. Several (five to ten) years of good quality measurements will be needed to begin to decipher water quality trends and the status of rivers and streams relative to the New Hampshire surface water quality standards. Water quality data from the stretch of river sampled by volunteers are presented in graphs in Appendix E. These graphs are included in the report to show how water quality conditions change from upstream to downstream. The current report format will describe water quality conditions on a site-by-site basis.

All results generated by the Cocheco River VRAP 2000 were collected using the VRAP Field Datasheet and Field Sampling Protocols, 2000 (see Appendix F).

### 3.1. 26-Cch: Central Street Bridge, Farmington, NH

#### 3.1.1. Site Description

This site is located at the upstream end of a seven thousand-foot-long flood control project constructed by the U.S. Army Corps of Engineers in the 1950's-1980's to straighten and clear the channel (Figure 1). Stream flows diminish from a small river to a trickle as the monitoring season grows warmer. Some residential development upstream remains unsewered, relying on old septic systems. The streambed at the site consists of cobbles and is apt to be strewn with trash.

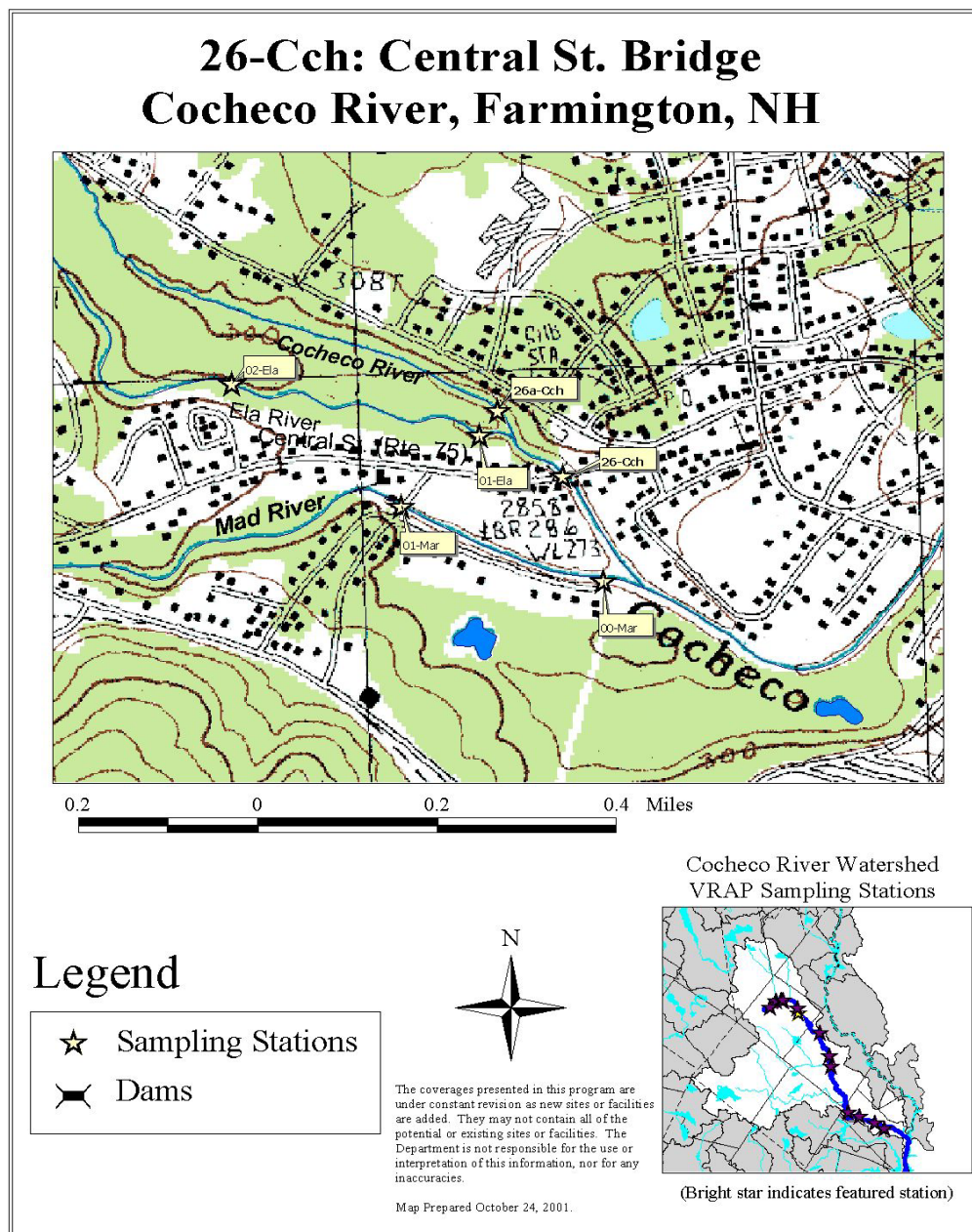


Figure 1. Station location map for 26-Cch, Cocheco River, New Hampshire, VRAP 2000.

### 3.1.2. Results and Discussion

Water quality measurements were made in the field using handheld meters, including water temperature, dissolved oxygen (DO), pH, turbidity, and specific conductance (conductivity). Two samples were collected for laboratory analysis (*E. coli* bacteria). All measurements and samples met the Quality Assurance and Quality Control (QA/QC) requirements, and, with the exception of one *E. coli* bacteria sample collected on July 31, 2000, all volunteer results from 26-Cch in the year 2000 were within Class B Water Quality Standards (see Table 1).

**Table 1. Monitoring Summary: 26-Cch. VRAP, Year 2000.**

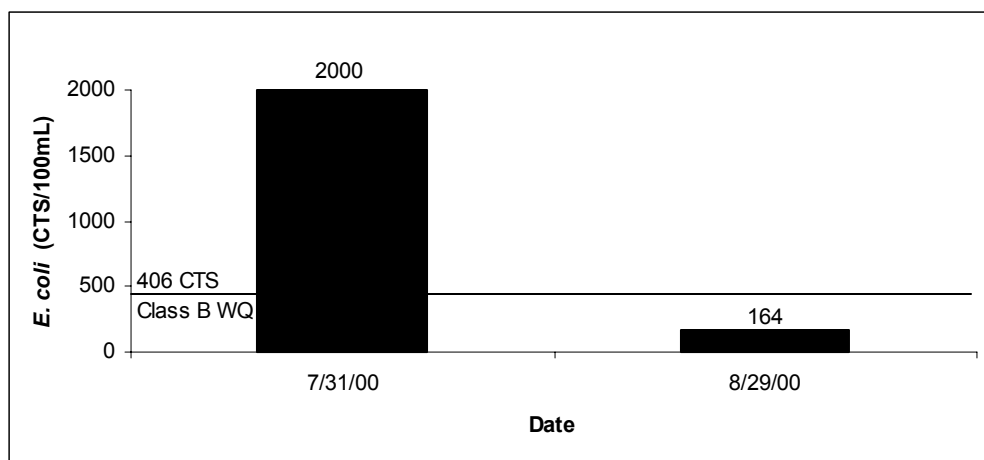
Parameter	Samples Collected	Samples Meeting QA/QC Requirements	Acceptable Samples Not Meeting State Criteria	Data Range	Standard*
DO (mg/L)	6	6	0	8.12 - 9.42	>5
DO (% sat.)	6	6	0	86.6 - 99.7	>75
pH (std. Units)	6	6	0	6.61 - 7.33	6.5-8.0
Turbidity (NTUs)	6	6	0	1.33 - 2.6	<10 NTU above background
Conductivity (µmho/cm)	6	6	0	52 - 94.2	NA
<i>E. coli</i> (Cts/100mL)	2	2	1	164 – 2000<	<406

\*Abbreviated standard values have been used in this table for quick reference. Please see Env-Ws 1700 and RSA 485-A:8 for complete Surface Water Quality Regulations.

#### 3.1.2.1. *E. coli*

Volunteer sampling since 1998 has indicated that high *E. coli* levels in the Cocheco River are often associated with rain events, which has prompted an interest among volunteers to better understand the relationship between rain and *E. coli* levels. It is possible that precipitation causing overland flow and/or stormwater drainage in the watershed may carry *E. coli* into the river. Rain was reported within three days prior and during the sampling on July 31<sup>st</sup>, when the *E. coli* concentration was >2000 CTS/100mL (see Figure 2).

Volunteer investigations into *E. coli* upstream and in the Ela River tributary are ongoing, as these areas are suspected of contributing *E. coli* to the Cocheco River. Volunteers collected samples from three sites on the Ela River for *E. coli* analysis in 2000, however none of the results showed elevated *E. coli* levels despite the occurrence of rain on two of the dates. It is possible that *E. coli* levels temporarily elevated by the flushing action of rain are not always detected at the time of sampling. Volunteers may have collected their samples just before or after *E. coli* was flushed through the area, or the amount of rain did not cause a flush of watershed drainage to occur. Additional *E. coli* sampling will help to determine the extent and cause(s) of *E. coli* in the river.



**Figure 2. *E. coli* bacteria counts. Cocheco River at 26-Cch, Central Street Bridge, Farmington, NH. VRAP, Year 2000.**

### 3.1.2.2. Dissolved Oxygen

Figure 3 shows dissolved oxygen concentration and water temperature during 2000. Levels of DO sustained above the standards are considered adequate for wildlife populations and other desirable water quality conditions. The Class B New Hampshire surface water quality standards for DO include a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 % of saturation (% sat.). In other words, there are criteria for both concentration and saturation that must be met before the river can be considered as meeting DO standards. Although volunteer results revealed adequate DO concentration and saturation, the samples collected by volunteers may not reflect the lowest DO levels reached in the river at this location.

Rivers and streams with vegetation experience daily fluctuations in DO concentration and % sat. due to photosynthesis (oxygen production during daylight) and respiration (oxygen use, carbon dioxide production). Low DO levels are typically reached during the early morning hours, when photosynthesis has not been occurring since sundown but respiration and the consumption of oxygen has continued throughout the night. Peak DO levels are typically reached during the afternoon.

Levels of DO sustained above the standards are considered adequate for wildlife populations and other desirable water quality conditions. However, the results may not show an indication of potential DO depletion in the river because the sampling was done after the ideal time period for sampling worst-case DO conditions (5:00-8:00 a.m.). The earliest samples for DO at this site were taken at 9:30 and 10:15 a.m., and samples were collected as late as 2:55 p.m. Additional samples collected during the early morning are needed to confirm that the river is meeting dissolved oxygen standards at this location.

The results of the Cocheco River VRAP 2000 DO % saturation sampling were above the minimum daily average of 75% saturation. However, because sampling was conducted after 9:30 a.m., the results provided by volunteers may not show the lowest oxygen saturation reached in the river. Also, an accurate determination of whether the DO standard is met for % saturation is made using multiple measurements of saturation

collected per sampling day. Therefore, additional DO saturation data collected at this location are needed.

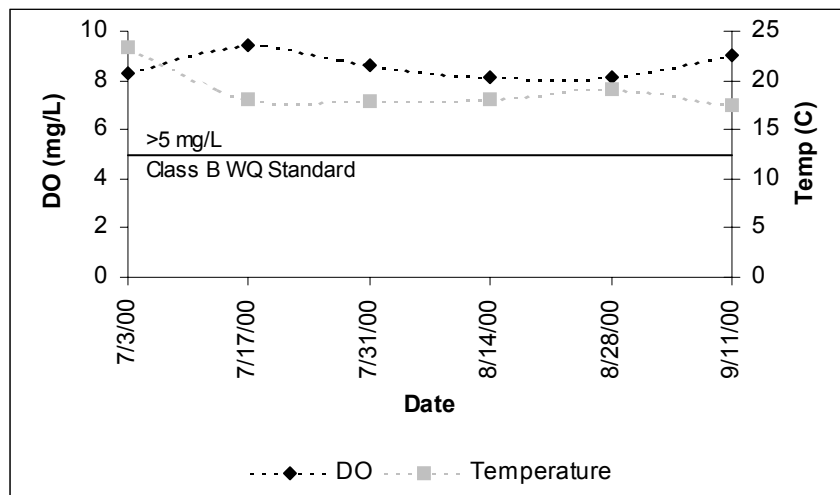


Figure 3. Dissolved Oxygen (DO) Concentration vs. Temperature. Cocheco River at 26-Cch, Central Street Bridge, Farmington, NH. VRAP, Year 2000.

### 3.1.3. Recommendations

- Baseline Monitoring:** Volunteers are encouraged to continue baseline monitoring activities at this location to establish a record of water quality during all conditions, and to confirm that this area of the river attains standards. The more information in the baseline data set, the more will be known about the river's water quality dynamics, or variations. Volunteer monitoring augments the data collection and river management efforts of DES as well as local decision makers.

VRAP volunteers are making water quality data available across the State of New Hampshire, in some locations for the very first time. Prior to volunteer monitoring efforts, very little information about the river in this location was available. The volunteer sampling that has taken place has helped create the recommendations in this report.

Special attention should be given to weather conditions previous to and during the time of sampling. For data interpretation purposes, it is extremely important that weather conditions are provided to VRAP along with water quality data. A complete discussion of water quality conditions cannot be made without a record of weather conditions.

- *E. coli*: Continued *E. coli* sampling at this location is encouraged. The sampling and analyses contributed by volunteers and laboratory facilities has been an important preliminary investigation tool for gathering information about *E. coli* conditions in the Cocheco River watershed. *E. coli* can influence recreational and other potential water quality aspects. Therefore it is important to monitor *E. coli*, especially where swimming might be expected.

Local watershed volunteers collected “instantaneous” samples for *E. coli* bacteria analysis. The frequency of collection (less than three samples collected within a sixty-day period) places these measurements in the instantaneous category. This means that the sample results with >406 CTS/100mL indicate potentially elevated levels of *E. coli*. The area requires additional samples in order to verify the presence and persistence of elevated *E. coli* levels.

DES reviews incoming water quality data, and responds to instantaneous exceedences with a program for verification of potential problems. This process requires multiple samples, which are a more reliable source of data than single samples. Although any single sample containing more than 406 CTS/100mL is considered an exceedence of water quality standards, a geometric mean (a type of average) of three or more samples, as written in the surface water quality standards, is more descriptive of overall river conditions and helps to confirm persistence of potential *E. coli* contamination. If possible, collecting at least three samples during a sixty-day period is recommended, and should be coordinated with DES assessment activities.

Bracketing the area, sampling upstream and downstream from the location where elevated *E. coli* levels were detected, will help define the stretch of the river with potentially elevated *E. coli* levels. *E. coli* bacteria comes from a variety of sources, including the intestines of all warm blooded animals, polluted runoff, failing septic systems or inadequate sewer connections, and flow from wetland areas. Bracketing is usually one of the first steps in determining the extent and cause of elevated *E. coli* levels.

Future sampling efforts should be focused on wet weather events, as well as sampling on dry days to track *E. coli* levels during all summer weather conditions. To date, *E. coli* monitoring on the Cocheco River has indicated that elevated *E. coli* levels are associated with wet weather. Additional sampling during wet weather will help to detect and decipher sources of *E. coli*.

During wet weather studies DES attempts to sample *E. coli* levels before peak storm flow, during peak storm flow, and post peak storm flow. Typical DES wet weather studies include sampling at one, two, three, and five hours after the peak of storm flow, and require a predetermined amount of precipitation.

- *Dissolved Oxygen*: Keeping a record of DO will help to document variations in the river, and provide early detection of changes in the river. Prior to volunteer

monitoring efforts, little information about the river at this location was available. It is important to note that good DO levels at this location help to maintain DO levels downstream. Although the river appears to be meeting the minimum instantaneous DO concentration (5 mg/L) at this location, baseline monitoring should continue with special attention to the time of sampling.

Volunteers are encouraged to conduct future sampling efforts in the early morning (5:00-8:00 a.m.), when DO levels are typically lowest. Results obtained during the afternoon hours may not reveal incidences of oxygen depletion in the river, although this information will contribute to the documentation of daily and seasonal water quality variability. Samples within the early morning hours will help determine the lowest concentrations of oxygen in the river, and help alert volunteers and DES to concentrations below the standard.

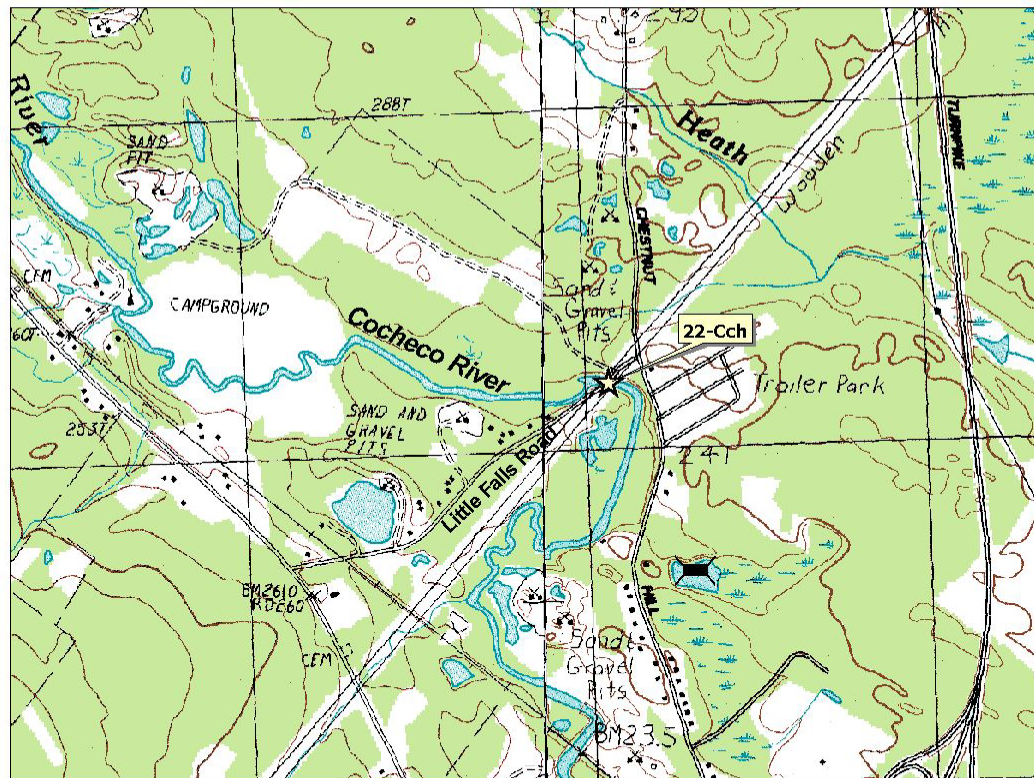
To determine if oxygen saturation in the river at this location falls below water quality standards, monitoring data must represent worst and best-case scenarios of DO saturation. Volunteers working with DES can provide the watershed community with the necessary morning **and** afternoon data points. Arrangements for sampling oxygen saturation in the river more than once per day can be made through VRAP and the Ambient River Monitoring Program.

### **3.2. 22-Cch: Little Falls Road Bridge, Rochester, NH**

#### **3.2.1. Site Description**

The Cocheco River flows through forested land here, just above the Little Falls (Figure 4). Beavers build a dam at this bridge each year. There is both residential and industrial development upstream. In 1999, volunteers discovered that the electromagnetic field of power transmission lines passing overhead interferes with the function of the VRAP analytical meters. As a result, field water quality measurements are taken at a distance from the sampling site.

## 22-Cch: Little Falls Rd. Cocheco River, Farmington, NH



0.3 0 0.3 0.6 Miles

### Legend

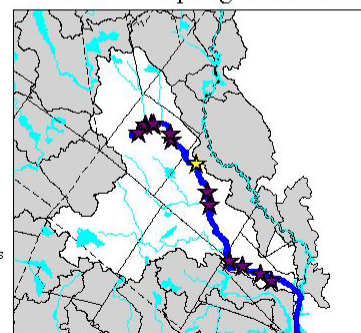
- ★ Sampling Stations
- ⌵ Dams



The coverages presented in this program are under constant revision as new sites or facilities are added. They may not contain all of the potential or existing sites or facilities. The Department is not responsible for the use or interpretation of this information, nor for any inaccuracies.

Map Prepared October 24, 2001.

### Cocheco River Watershed VRAP Sampling Stations



(Bright star indicates featured station)

**Figure 4. Station location map for 22-Cch, Cocheco River, New Hampshire, VRAP 2000.**

### 3.2.2. Results and Discussion

Six water quality measurements were made in the field for each baseline parameter except for DO, which was measured five times. Two samples were collected for laboratory analysis (*E. coli* bacteria). All measurements and samples met the QA/QC requirements. Volunteer DO and pH data suggest that the Cocheco River at 22-Cch may not meet Class B Water Quality Standards (see Table 2).

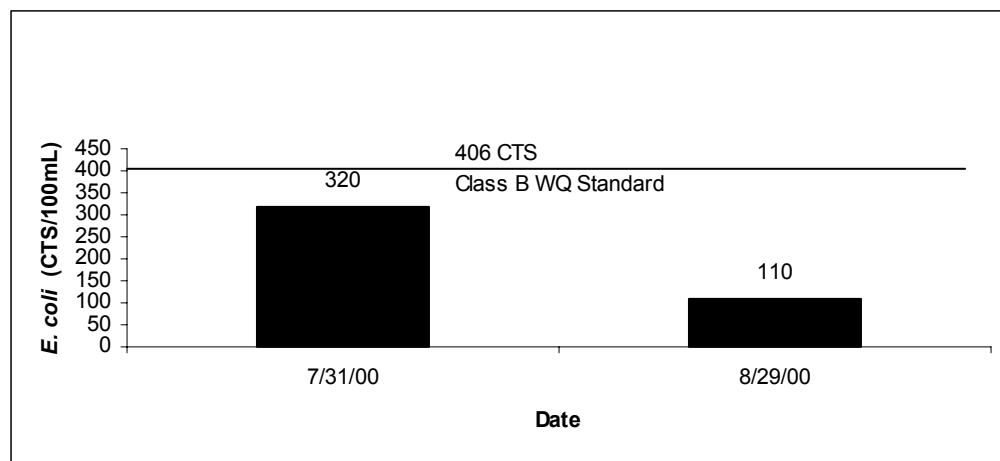
**Table 2. Monitoring Summary: 22-Cch. VRAP, Year 2000.**

Parameter	Samples Collected	Samples Meeting QA/QC Requirements	Acceptable Samples Not Meeting State Criteria	Data Range	Standard*
DO (mg/L)	5	5	0	6.89 - 9.4	>5
DO (% sat.)	5	5	2	73.7 - 107	>75
pH (std. Units)	6	6	3	6.45 - 6.92	6.5-8.0
Turbidity (NTUs)	6	6	0	1.66 - 2.41	<10 NTU above background
Conductivity (µmho/cm)	6	6	0	70 - 151.9	NA
<i>E. coli</i> (Cts/100mL)	2	2	0	110 - 320	<406

\*Abbreviated standard values have been used in this table for quick reference. Please see Env-Ws 1700 and RSA 485-A:8 for complete Surface Water Quality Regulations.

#### 3.2.2.1. *E. coli*

Figure 5 shows the *E. coli* counts during summer 2000.



**Figure 5. *E. coli* bacteria counts. Cocheco River at 22-Cch, Little Falls Road Bridge, Rochester, NH. VRAP, Year 2000.**

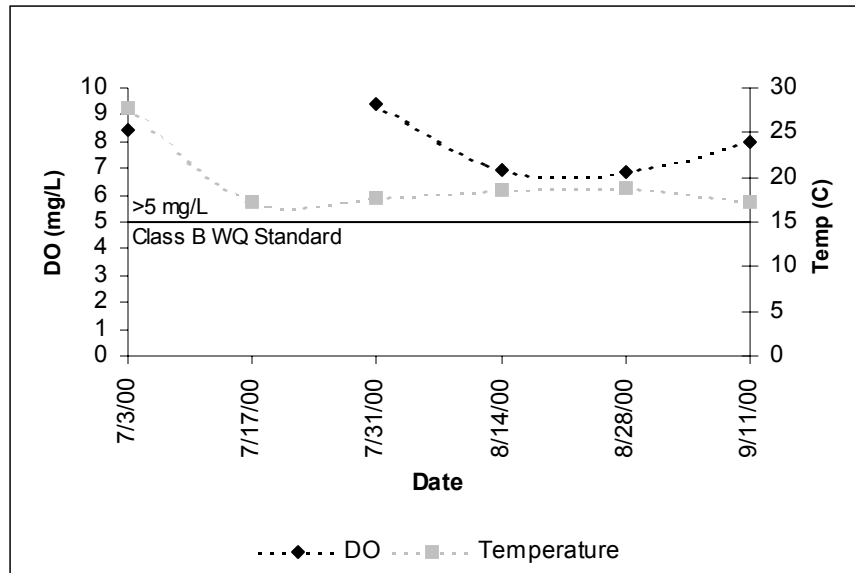
#### 3.2.2.2. Dissolved Oxygen

Figure 6 shows dissolved oxygen concentration and water temperature during 2000. The Class B New Hampshire surface water quality standards for DO include a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 % sat. In other words, there are criteria for both concentration and saturation that must be met before the river can be considered as meeting DO standards. Although volunteer sampling this year showed DO concentrations above the minimum instantaneous requirement of 5 mg/L, the samples collected by volunteers may not reflect the lowest DO levels reached in the river at this location.

Rivers and streams with vegetation experience daily fluctuations in DO concentration and % saturation due to photosynthesis (oxygen production during daylight) and respiration (oxygen use, carbon dioxide production). Low DO levels are typically reached during the early morning hours, when photosynthesis has not been occurring since sundown but respiration and the consumption of oxygen has continued throughout the night. Peak DO levels are typically reached during the afternoon.

Levels of DO sustained above the standards are considered adequate for wildlife populations and other desirable water quality conditions. However, the results may not show an indication of potential DO depletion in the river because the sampling was done after the ideal time period for sampling worst-case DO conditions (5:00-8:00 a.m.). All six measurements were taken after the lowest DO content is typically present in a river. Most samples were collected between 9:10 and 11:05 a.m., and sampling was conducted as late as 2:25 p.m. Additional samples collected during the early morning are needed to confirm that the river is meeting dissolved oxygen standards at this location.

Both morning (9:10 a.m.) and afternoon (2:02 p.m.) DO measurements recorded at this site on separate days in August were below 75 % saturation, which indicates that the saturation standard may not have been met. Further, because sampling was conducted after 9:10 a.m., the results provided by volunteers may not show the lowest oxygen saturation in the river. An accurate determination of whether the DO standard is met for % saturation is made using multiple measurements collected per sampling day. Therefore, additional DO saturation data is needed from this location.



**Figure 6. Dissolved Oxygen (DO) Concentration vs. Temperature. Cochemo River at 22-Cch, Little Falls Road Bridge, Rochester, NH. VRAP, Year 2000.**

### 3.2.2.3. pH

The pH at this location, ranging from 6.45 to 6.92, was measured below the state standard range on three of six monitoring dates. The precision of the VRAP pH meters ( $\pm 0.02$ ) requires that results within 0.02 of the standard range (6.5 to 8.0) are not considered out of range. For example, a reading of 6.48 is considered within range, while a reading of 6.47 falls below the standard range.

Site conditions are considered along with pH measurements because of the narrative portion of the pH standard. RSA 485-A:8 states that pH of Class B waters *shall be between 6.5 and 8.0, except when due to natural causes*. Wetlands can lower the pH of a river naturally by releasing tannic and humic acids from decaying plant material. If the sampling location is influenced by wetlands or other natural conditions, then the low pH measurements are not considered a violation of water quality standards. It is important to note that the New Hampshire water quality standard for pH is fairly conservative, thus pH levels slightly below the standard are not necessarily harmful to aquatic life. In this case, additional information about factors influencing pH levels is needed.

### 3.2.3. Recommendations

- **Baseline Monitoring:** Volunteers are encouraged to continue baseline monitoring activities at this location to establish a record of water quality during all conditions. VRAP volunteers are making an increasing amount of water quality data available, in some locations for the very first time. The sampling that has taken place has helped create the recommendations in this report, and VRAP monitoring augments the data collection and river management efforts of DES as well as local decision makers. The more information in the baseline data set, the more will be known about the river's water quality dynamics, or variations.

Special attention should be given to weather conditions previous to and during the time of sampling. For data interpretation purposes, it is extremely important that weather conditions are provided to VRAP along with water quality data. A complete discussion of water quality conditions cannot be made without a record of weather conditions.

- *E. coli*: Although the river appears to be meeting standards at this location continued *E. coli* sampling at this location is encouraged. *E. coli* can influence recreational and other potential water quality aspects. Therefore it is important to monitor *E. coli*, especially where swimming might be expected.

If possible, collecting at least three samples during a sixty-day period is recommended, and should be coordinated with DES assessment activities. Although any single sample containing more than 406 CTS/100mL is considered an exceedance of water quality standards, a geometric mean (a type of average) of three or more samples, as written in the surface water quality standards, is more descriptive of overall river conditions, and helps to confirm persistence of potential *E. coli* contamination.

- *Dissolved Oxygen*: Keeping a record of DO will help to document variations in the river, and provide early detection of changes in the river. Prior to volunteer monitoring efforts, little information about the river at this location was available. It is important to note that good DO levels at this location help to maintain DO levels downstream. Although the river appears to be meeting the minimum instantaneous DO concentration (5 mg/L) at this location, baseline monitoring should continue with special attention to the time of sampling.

Volunteers are encouraged to conduct future sampling efforts in the early morning (5:00-8:00 a.m.), when DO levels are typically lowest. Results obtained during the afternoon hours may not reveal incidences of oxygen depletion in the river, although this information will contribute to the documentation of daily and seasonal water quality variability. Samples within the early morning hours will help determine the lowest concentrations of oxygen in the river, and help alert volunteers and DES to concentrations below the standard.

To determine if oxygen saturation in the river at this location falls below water quality standards, monitoring data must represent worst and best-case scenarios of DO saturation. Volunteers working with DES can provide the watershed community with the necessary morning **and** afternoon data points. Arrangements for sampling oxygen saturation in the river more than once per day can be made through VRAP and the Ambient River Monitoring Program.

- *pH*: Volunteers can help determine if this location in the river meets the pH standard by providing DES with additional water quality data and information about the influences affecting water quality at this site. This process is not completed in the short term because of the variability of water quality and the

organization of volunteers involved. Volunteers may choose to plan one of the following phases each year, and contribute their observations and results to DES:

**Phase I:**

As a first response to low pH measurements, volunteers can investigate the immediate drainage area to determine patterns of runoff and flow. Are there wetlands in the area that are potentially influencing water quality at this location? A simple way to answer this question would be to walk around the area looking for wetland drainage upstream from the site. Topographic and GIS (Geographic Information Systems) maps may also provide useful information about drainage patterns in the immediate watershed area.

**Phase II:**

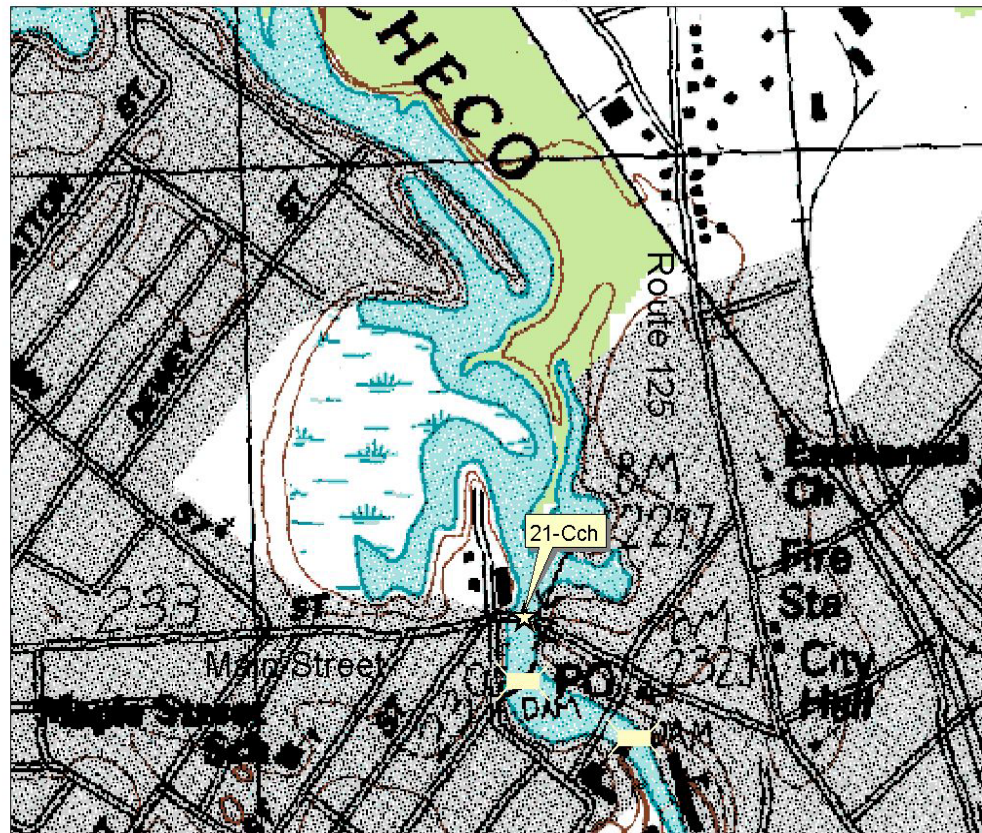
If wetland drainage is present, the next step is to sample upstream from the wetland's influence, if possible. Volunteers sampling upstream from a wetland may discover that pH is within the standard range, and that it is likely that the wetland itself is contributing to low pH in the river. If the pH remains low upstream from an influencing wetland it is possible that there is another source of acidity, and volunteer investigations should continue upstream. Continued investigations will help document possible influences, which can be incorporated into the assessment of water quality conditions.

### **3.3 21-Cch: North Main Street Bridge, Rochester, NH**

#### **3.3.1. Site Description**

In the heart of downtown on a busy street, the river passes beneath a beautiful double-arched bridge, which is a Rochester landmark (Figure 7). This bridge is located just above a dam, which impounds the water (holds back the flow) for nearly a mile upstream. These impounded waters are choked with vegetation including Variable Milfoil, an invasive exotic aquatic plant. This was the location of large mills in the 19<sup>th</sup> century and the banks around the dam have been greatly modified to control river flow through the urban city center.

## 21-Cch: North Main St. Bridge Rochester, NH



0.1 0 0.1 0.2 Miles

### Legend

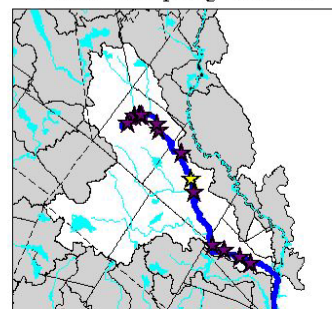
- ★ Sampling Stations
- ✕ Dams



The coverages presented in this program are under constant revision as new sites or facilities are added. They may not contain all of the potential or existing sites or facilities. The Department is not responsible for the use or interpretation of this information, nor for any inaccuracies.

Map Prepared October 24, 2001.

### Cocheco River Watershed VRAP Sampling Stations



(Bright star indicates featured station)

Figure 7. Station location map for 21-Cch, Cocheco River, New Hampshire, VRAP 2000.

### 3.3.2. Results and Discussion

Six water quality measurements were made in the field for each parameter except for DO percent of saturation (% sat.), which was measured five times. Two samples were collected for laboratory analysis (*E. coli* bacteria). All measurements and samples met the QA/QC requirements. Volunteer DO, pH, and *E. coli* data indicate that the Cocheco River at 21-Cch may not meet Class B Water Quality Standards (see Table 3).

**Table 3. Monitoring Summary: 21-Cch. VRAP, Year 2000.**

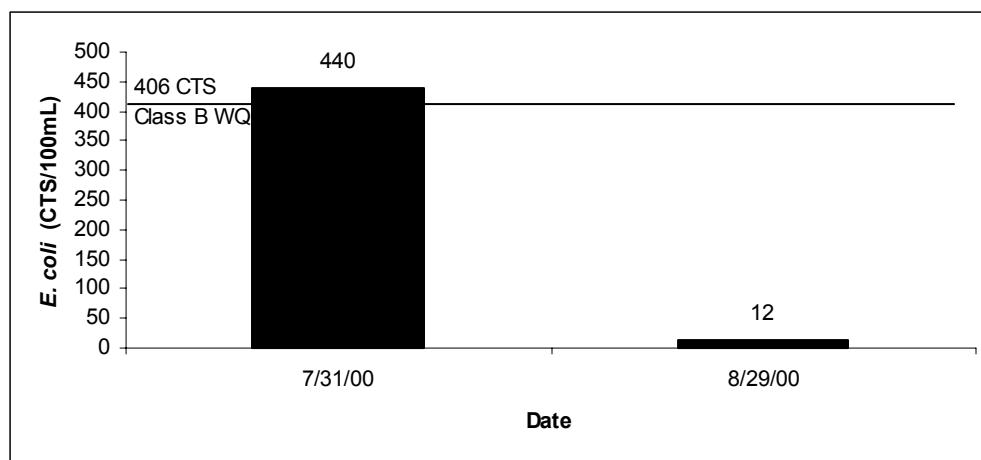
Parameter	Samples Collected	Samples Meeting QA/QC Requirements	Acceptable Samples Not Meeting State Criteria	Data Range	Standard*
DO (mg/L)	6	6	0	5.62 - 7.3	>5
DO (% sat.)	5	5	2	62.7 - 80.6	>75
pH (std. Units)	6	6	5	6.14 - 6.63	6.5-8.0
Turbidity (NTUs)	6	6	0	1.8 - 3.6	<10 NTU above background
Conductivity (µmho/cm)	6	6	0	81 - 147.6	NA
<i>E. coli</i> (CTS/100mL)	2	2	1	12 - 440	<406

\*Abbreviated standard values have been used in this table for quick reference. Please see Env-Ws 1700 and RSA 485-A:8 for complete Surface Water Quality Regulations.

#### 3.2.3.1. *E. coli*

Rain at the time of sampling, impounded water, and wildlife may have contributed to elevated *E. coli* counts at 21-Cch on July 31, 2000 (see Figure 8). A dam just below the site holds back the river and may encourage the survival and accumulation of *E. coli* by creating warmer water temperatures and less vigorous flow. Wildlife, containing *E. coli* in their fecal material, is also known to congregate at this location. The impounded water may provide an attractive habitat for wildlife, which can lead to fecal deposition and the conditions that encourage bacterial growth.

Volunteer data has not previously shown *E. coli* counts above the state standard at this location. Eight samples collected by volunteers in 1999 contained acceptable *E. coli* counts (VRAP, 1999). Additional information is required to determine the extent and cause(s) of high *E. coli* levels at this location.



**Figure 8. *E. coli* bacteria counts. Cocheco River at 21-Cch, North Main Street Bridge, Rochester, NH. VRAP, Year 2000.**

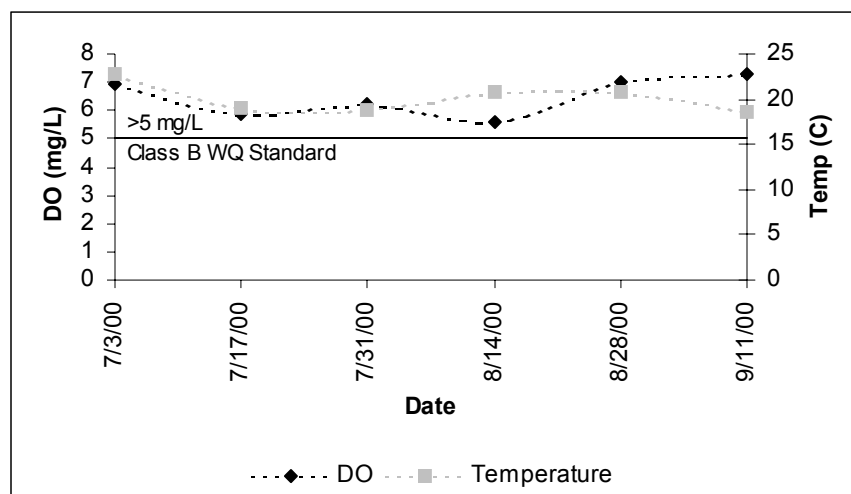
### 3.2.3.2. Dissolved Oxygen

Figure 9 shows dissolved oxygen concentration and water temperature during 2000. The Class B New Hampshire surface water quality standards for DO include a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 % saturation. In other words, there are criteria for both concentration and saturation that must be met.

Rivers and streams with vegetation experience daily fluctuations in DO concentration and % saturation due to photosynthesis (oxygen production during daylight) and respiration (oxygen use, carbon dioxide production). Low DO levels are typically reached during the early morning hours, when photosynthesis has not been occurring since sundown but respiration and the consumption of oxygen has continued throughout the night. Peak DO levels are typically reached during the afternoon.

Volunteer sampling this year showed DO concentrations above the minimum instantaneous requirement of 5 mg/L. Sustained concentrations above standards are considered adequate to support wildlife populations and other desirable water quality conditions. However, the volunteer samples were collected between 8:40 and 10:55 a.m., and sampling was conducted as late as 2:00 p.m. These measurements were taken after the worst-case, or lowest, DO content is typically present in a river.

The saturation of oxygen was measured below 75% on two occasions. An accurate determination of whether the DO standard is met for % saturation is made using multiple measurements of saturation collected per sampling day. Therefore, DO saturation at this location requires further investigation.



**Figure 9. Dissolved Oxygen (DO) Concentration vs. Temperature. Cochemo River at 21-Cch, North Main Street Bridge, Rochester, NH. VRAP, Year 2000.**

### 3.3.3 Recommendations

- **Baseline Monitoring:** Volunteers are encouraged to continue baseline monitoring activities at this location to establish a record of water quality during all conditions. VRAP volunteers are making an increasing amount of water quality data available, in some locations for the very first time. The more information in the baseline data set, the more will be known about the river's water quality dynamics, or variations.

Special attention should be given to weather conditions previous to and during the time of sampling. For data interpretation purposes, it is extremely important that weather conditions are provided to VRAP along with the water quality data. A complete discussion of water quality conditions cannot be made without a record of weather conditions.

- ***E. coli*:** Additional sampling for *E. coli* bacteria is recommended at this location. Volunteers have not detected elevated *E. coli* levels at this location before, but the presence of 440 CTS/100mL in one of the year 2000 samples should be investigated. *E. coli* can influence recreational and other potential water quality aspects. Therefore it is important to monitor *E. coli*, especially where swimming might be expected.

Bracketing the area, sampling upstream and downstream from the site, will help define the stretch of the river potentially contaminated with elevated *E. coli* levels. *E. coli* bacteria comes from a variety of sources, including the intestines of all warm blooded animals, polluted runoff, failing septic systems or inadequate sewer connections, and flow from wetland areas. Bracketing is one of the first steps in determining the extent and cause of elevated *E. coli* levels.

If possible, collecting at least three samples during a sixty-day period is recommended, and should be coordinated with DES assessment activities. Although any single sample containing more than 406 CTS/100mL is considered an exceedance of water quality standards, a geometric mean (a type of average) of three or more samples, as written in the surface water quality standards, is more descriptive of overall river conditions, and helps to confirm persistence of potential *E. coli* contamination.

Special attention should also be given to weather conditions previous to and during the time of sampling. So far, *E. coli* monitoring on the Cocheco River has indicated that elevated *E. coli* levels are associated with wet weather. Future sampling efforts should be focused on wet weather events, as well as sampling on dry days to detect changes in *E. coli* levels during dry weather. For data interpretation purposes, it is imperative that weather conditions are provided to VRAP along with the water quality data.

- *Dissolved Oxygen*: Keeping a record of DO will help to determine natural fluctuations and provide early detection of changes in the river. Although the river appears to be meeting the minimum instantaneous DO concentration (5 mg/L) at this location, baseline monitoring should continue with special attention to the time of sampling.

Volunteers are encouraged to conduct future sampling efforts in the early morning (5:00-8:00 a.m.) to obtain the lowest, or worst-case, DO concentration readings. Sampling within the early morning hours will help alert volunteers and DES to concentrations below the standard.

To determine if oxygen saturation in the river at this location falls below water quality standards, monitoring data must represent worst and best-case scenarios of DO saturation. Volunteers working with DES can provide the watershed community with the necessary morning **and** afternoon data points. Arrangements for sampling oxygen saturation in the river more than once per day can be made through VRAP and the Ambient River Sampling Program.

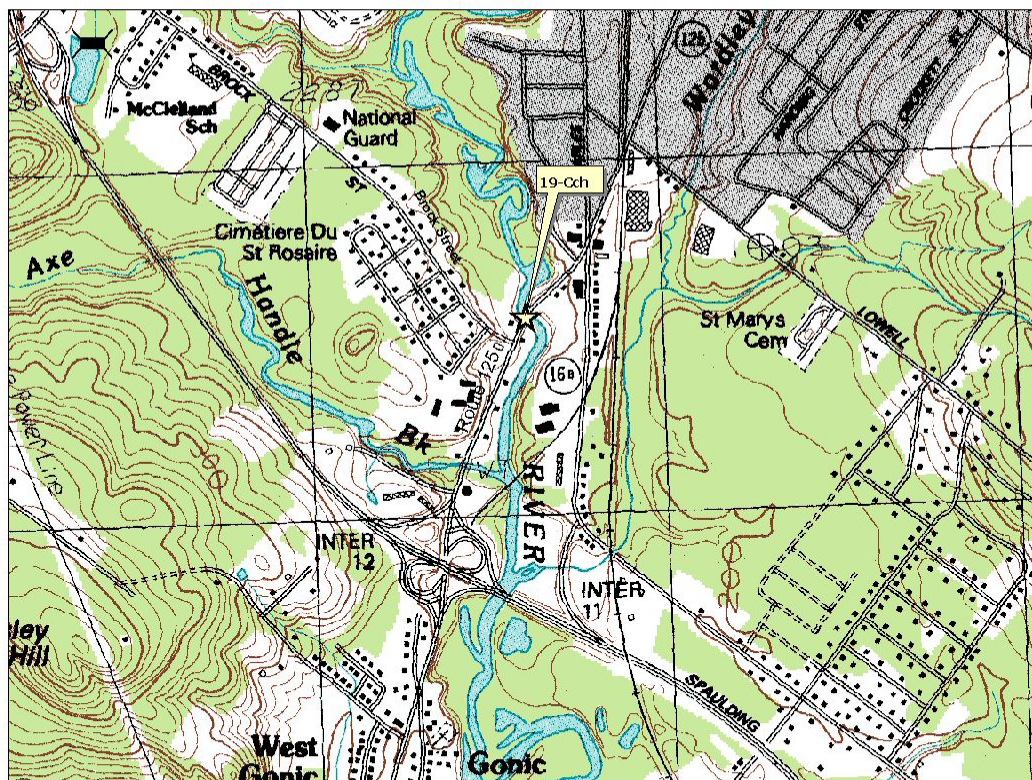
- *pH*: Additional volunteer investigation and sampling is recommended, as specified in the recommendations for 22-Cch.

### **3.4 19-Cch: Route 125 Bridge, Rochester, NH**

#### **3.4.1 Site Description**

This site is at the heavily trafficked southern gateway to Rochester (Figure 10). This location marks the downstream limit of a reach of the river which passes through the “backyards” of Rochester: behind the fairgrounds, the National Guard Armory, a former wrecking yard, a school playground and residential development. The river glides under the bridge in a streambed of silt and sand.

# 19-Cch: Rt. 125 Bridge Cocheco River, Rochester, NH



0.2 0 0.2 0.4 Miles

## Legend

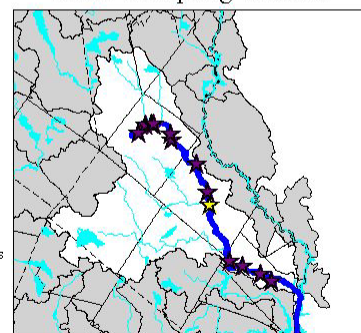
- ★ Sampling Stations
- ⌵ Dams



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Map Prepared October 24, 2001.

## Cocheco River Watershed VRAP Sampling Stations



(Bright star indicates featured station)

Figure 10. Station location map for 19-Cch, Cocheco River, New Hampshire, VRAP 2000.

### 3.4.2 Results and Discussion

Six water quality measurements were made in the field for each parameter except for DO percent of saturation, which was measured five times. Two samples were collected for laboratory analysis (*E. coli* bacteria and several metals species). All measurements and samples met the QA/QC requirements. Volunteer *E. coli* and pH data indicate that the Cocheco River at 19-Cch may not meet Class B Water Quality Standards (see Table 4).

**Table 4. Monitoring Summary: 19-Cch. VRAP, Year 2000.**

Parameter	Samples Collected	Samples Meeting QA/QC Requirements	Acceptable Samples Not Meeting State Criteria	Data Range	Standard*
DO (mg/L)	6	6	0	7.26 - 8.3	>5
DO (% sat.)	5	5	0	79.1 - 88.8	>75
pH (std. Units)	6	6	3	6.09 - 7.19	6.5-8.0
Turbidity (NTUs)	6	6	0	2.9 - 5.6	<10 NTU above background
Conductivity (µmho/cm)	6	6	0	90 - 164.1	NA
<i>E. coli</i> (CTS/100mL)	2	2	1	166 - 850	<406
Al (mg/L)	2	2	0	0.084 - 0.097	<0.75**
Cu (mg/L)	2	2	0	<0.005	<0.0036**
Pb (mg/L)	2	2	0	<0.050	<0.014**
Zn (mg/L)	2	2	0	<0.050	<0.0362**

\*Abbreviated standard values have been used in this table for quick reference. Please see Env-Ws 1700 and RSA 485-A:8 for complete Surface Water Quality Regulations.

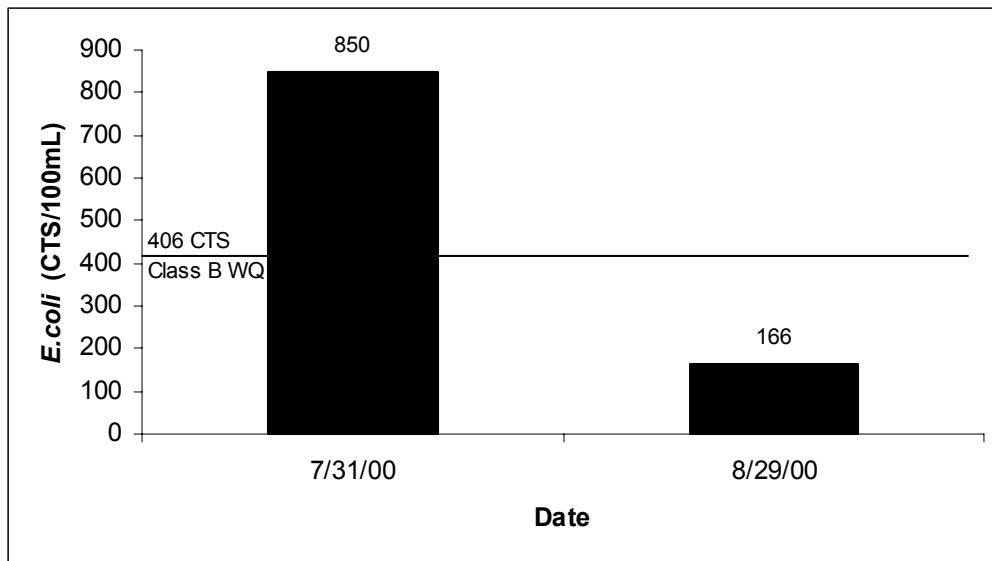
\*\* Metals standards represent fresh water acute criteria.

#### 3.4.2.1 *E. coli*

Figure 11 shows the *E. coli* counts during summer 2000. Rain was reported within three days prior and during the sampling on July 31<sup>st</sup>, when the *E. coli* concentration was 850 CTS/100mL. Volunteer sampling since 1998 suggest that high *E. coli* levels in the Cocheco River are often associated with rain events, which has prompted an interest among volunteers to better understand the relationship between rain and *E. coli* levels.

In 1999, four of nine samples collected at this location contained elevated *E. coli* levels (VRAP, 1999). It is possible that precipitation causing overland flow and/or stormwater drainage in the watershed may carry *E. coli* into the river. It is also possible that there is an inadequate connection to the sewer system, causing *E. coli* to flow into the river

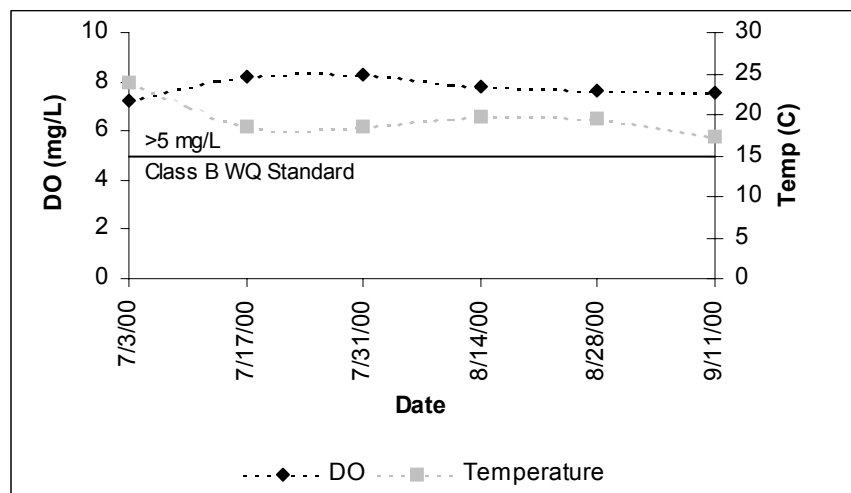
through the storm drain system. The city of Rochester Public Works Department is aware of the *E. coli* results, and is working with volunteers to investigate the cause and extent of the elevated *E. coli* levels.



**Figure 11. *E. coli* bacteria counts. Cocheco River at 19-Cch, Route 125 Bridge, Rochester, NH. VRAP, Year 2000.**

#### 3.4.2.2 Dissolved Oxygen

Figure 12 shows dissolved oxygen concentration and water temperature during 2000. These results do not give DES and the volunteers an idea of the extent of DO depletion in the river at this location, because the sampling was done after the ideal time period for sampling worst-case DO conditions (5:00-8:00 a.m.). Volunteer results from 1999 were collected within the early morning hours, and revealed potentially low saturation of DO on several occasions (VRAP, 1999).



**Figure 12. Dissolved Oxygen (DO) Concentration vs. Temperature. Cocheco River at 19-Cch, Route 125 Bridge, Rochester, NH. VRAP, Year 2000.**

#### 3.4.2.3 pH

The pH at this location, ranging from 6.09 to 7.19, was measured below the state standard range on three of six monitoring dates. Site conditions are considered together with pH measurements because of the narrative portion of the pH standard. RSA 485-A:8 states that pH of Class B waters *shall be between 6.5 and 8.0, except when due to natural causes*. Wetlands can lower the pH of a river naturally by releasing tannic and humic acids from decaying plant material. If the sampling location is influenced by wetlands or other natural conditions, then the low pH measurements are not considered a violation of water quality standards. It is important to note that the New Hampshire water quality standard for pH is fairly conservative, thus pH levels slightly below the standard are not necessarily harmful to aquatic life. In this case, additional information about factors influencing pH levels is needed.

#### 3.4.2.4 Metals

Samples for total metals analysis were collected on two dates in 2000 at this location. The samples were analyzed for the concentration (mg/L) of four metals: aluminum (Al), Copper (Cu), Lead (Pb), and Zinc (Zn). The concentrations of aluminum and lead were acceptable according to state standards; sample results were below the acute freshwater criteria. All samples for copper and zinc were below the laboratory detection limit of 0.050 mg/L. The standards for copper and zinc are also below the detection limit, making a comparison with standards impossible at this time. These results will be considered with other data available to DES when an assessment of this location is made. Volunteers did not record the necessary weather conditions on two of three sampling dates.

### 3.4.3 Recommendations

- *Baseline Monitoring:* Volunteers are encouraged to continue baseline monitoring activities at this location to establish a record of water quality during all conditions. VRAP volunteers are making an increasing amount of water quality data available, in some locations for the very first time. The more information in the baseline data set, the more will be known about the river's water quality dynamics, or variations.

Special attention should be given to weather conditions previous to and during the time of sampling. For data interpretation purposes, it is extremely important that weather conditions are provided to VRAP along with the water quality data. A complete discussion of water quality conditions cannot be made without a record of weather conditions.

- *E. coli:* Additional sampling for *E. coli* bacteria is recommended at this location. *E. coli* concentrations can influence recreational and other potential water quality aspects. Therefore it is important to monitor *E. coli*, especially where swimming might be expected. Volunteers are encouraged to continue to work with the City of Rochester to investigate *E. coli* levels.

Bracketing the area, sampling upstream and downstream from the site, will help define the stretch of the river potentially contaminated with elevated *E. coli* levels. *E. coli* bacteria comes from a variety of sources, including the intestines of all warm blooded animals, polluted runoff, failing septic systems or inadequate sewer connections, and flow from wetland areas. Bracketing is one of the first steps in determining the extent and cause of elevated *E. coli* levels.

If possible, collecting at least three samples during a sixty-day period is recommended, and should be coordinated with DES assessment activities. Although any single sample containing more than 406 CTS/100mL is considered an exceedance of water quality standards, a geometric mean (a type of average) of three or more samples, as written in the surface water quality standards, is more descriptive of overall river conditions, and helps to confirm persistence of potential *E. coli* contamination.

Future sampling efforts should be focused on wet weather events, as well as sampling on dry days to track *E. coli* levels during dry weather. For data interpretation purposes, it is imperative that weather conditions are provided to VRAP along with the water quality data.

- *Dissolved Oxygen*: Volunteers are encouraged to collect DO data during early morning hours (5:00-8:00 a.m.), when DO levels are typically lowest. Results obtained outside these hours may not reveal incidences of oxygen depletion in the river, although this information will contribute to documentation of daily and seasonal water quality variability. Continual observations and monitoring in this area will alert volunteers and DES to any change in the stream's ability to retain DO.

To determine if oxygen saturation in the river at this location falls below water quality standards, monitoring data must represent worst and best-case scenarios of DO saturation. Volunteers working with DES can provide the watershed community with the necessary morning **and** afternoon data points. Arrangements for sampling oxygen saturation in the river more than once per day can be made through VRAP and the Ambient River Sampling Program.

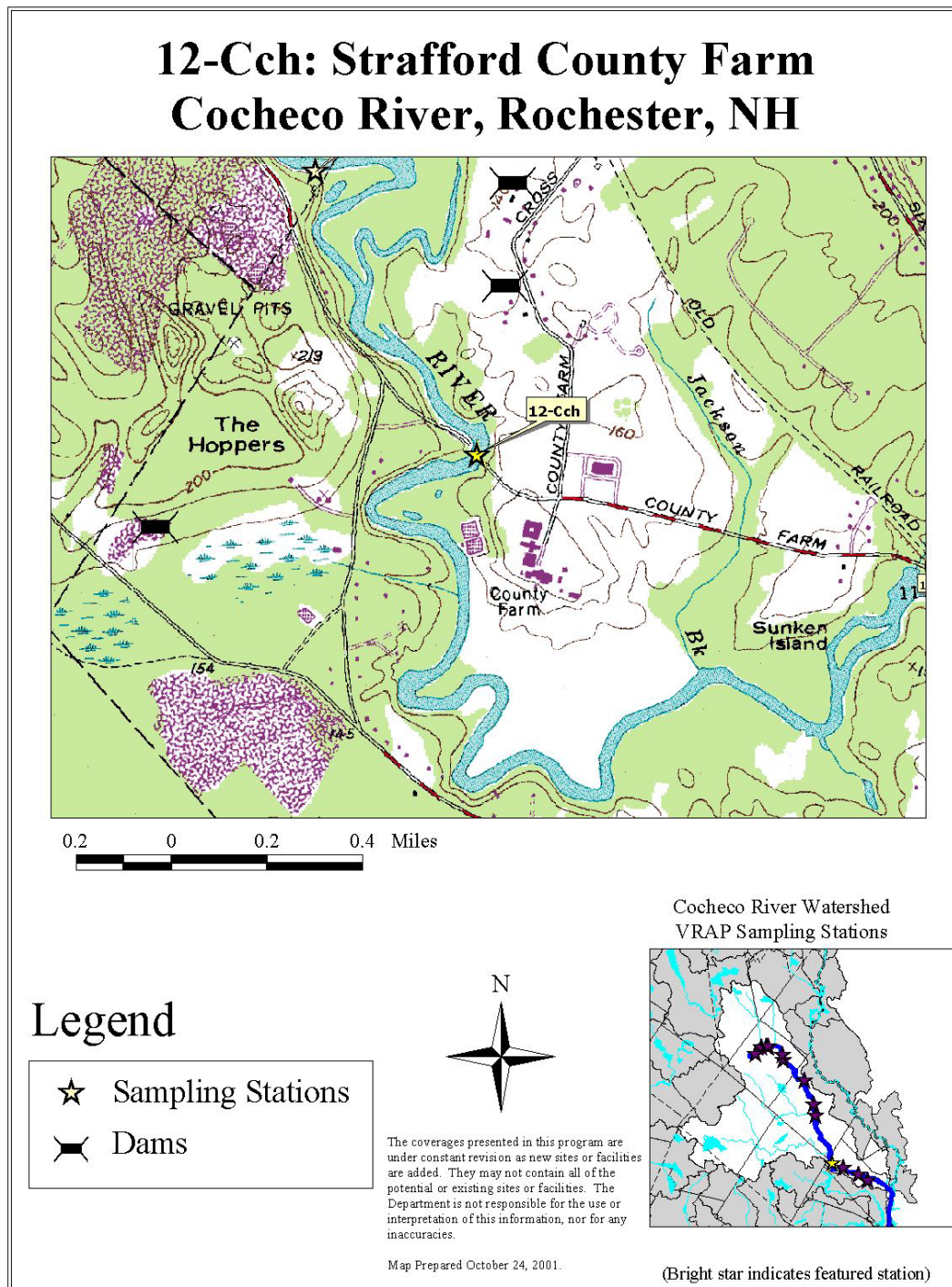
- *pH*: Additional volunteer investigation and sampling is recommended, as specified in the recommendations for 22-Cch.

### **3.5 12-Cch: Strafford County Farm, Dover, NH**

#### **3.5.1 Site Description**

About twenty years ago a bridge crossing the river at 12-Cch was burned by vandals, closing off traffic, but the stonework remains mark the site. Located on a forested bend of the river at the Strafford County Farm, this is the upper limit of the water impounded above Watson Dam three miles downstream (Figure 13). The river is broad and deep

with large over-hanging trees on the banks. Round-topped and smoothed outcroppings in the river are bedrock, which was a logical footing for the bridge. There are boulders strewn by glaciers just upstream, and downstream the riverbed changes to clay. This is the nearest volunteer monitoring station downstream from the Rochester Wastewater Treatment Facility, a golf course, a cement plant, a large complex of agricultural fields, and a regional landfill.



**Figure 13. Station location map for 12-Cch, Cocheco River, New Hampshire, VRAP 2000.**

### 3.5.2 Results and Discussion

Seven water quality measurements were made in the field for each parameter, and two samples were collected for laboratory analysis (*E. coli* bacteria and several nutrient parameters). All samples met the QA/QC requirements. DO and pH data indicate that the Cocheco River at 12-Cch may not meet Class B Water Quality Standards (Table 5).

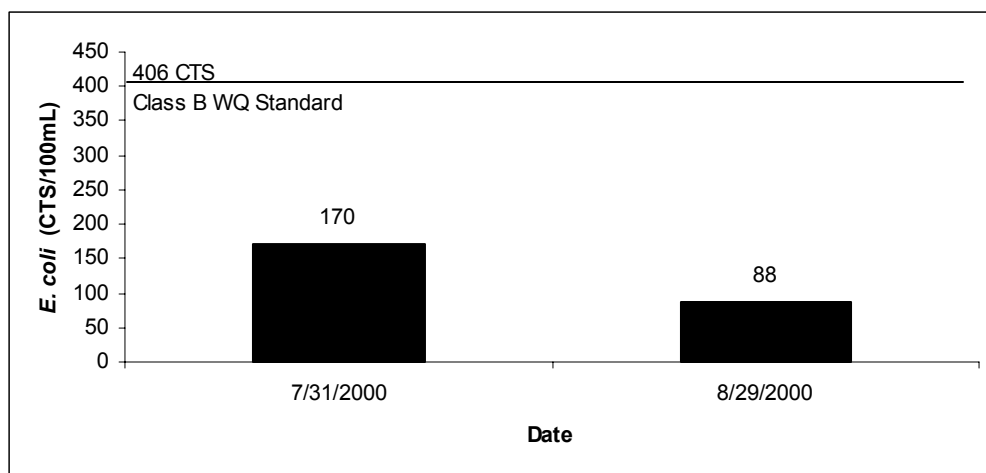
**Table 5. Monitoring Summary: 12-Cch. VRAP, Year 2000.**

Parameter	Samples Collected	Samples Meeting QA/QC Requirements	Acceptable Samples Not Meeting State Criteria	Data Range	Standard*
DO (mg/L)	7	7	0	5.43 - 8.26	>5
DO (% sat.)	7	7	3	63.8 - 85.5	>75
pH (std. units)	7	7	2	6.38 - 7.01	6.5-8.0
Turbidity (NTUs)	7	7	0	3.1 - 5.8	<10 above backgrd
Conductivity (µmho/cm)	7	7	0	110 - 190	NA
<i>E. coli</i> (cts/100 mL)	2	2	0	88 - 170	<406
Total Phosphorus (mg/L)	2	2	NA	0.101 - 0.21	NA
TKN (mg/L)	2	2	NA	0.51 - 0.75	NA
NH <sub>3</sub> (mg/L)	2	2	NA	0.1 - 0.34	NA
NO <sub>3</sub> (mg/L)	2	2	NA	0.39 - 1.18	NA

\*Abbreviated standard values have been used in this table for quick reference. Please see Env-Ws 1700 and RSA 485-A:8 for complete Surface Water Quality Regulations.

#### 3.5.2.1 *E. coli*

Figure 14 shows the *E. coli* counts during summer 2000.

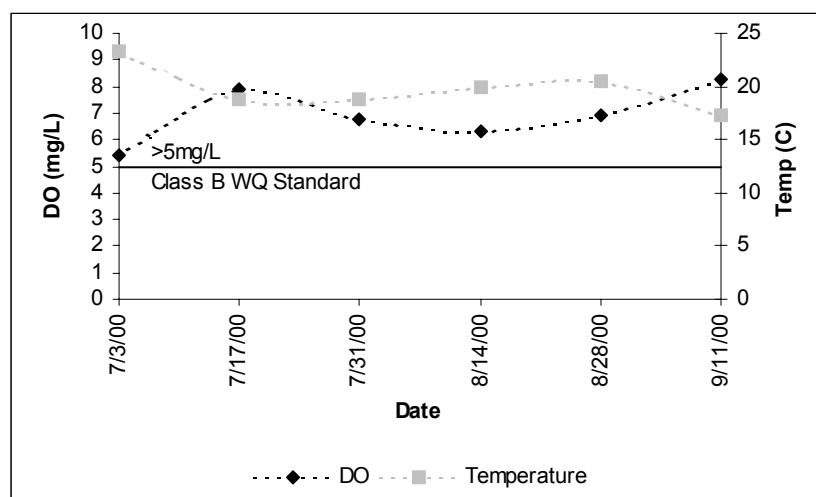


**Figure 14. *E. coli* bacteria counts. Cochecho River at 12-Cch, Strafford County Farm, Dover, NH. VRAP, Year 2000.**

### 3.5.2.2 Dissolved Oxygen

Figure 15 shows DO concentration and water temperature during 2000. Volunteer sampling showed DO concentrations above the minimum instantaneous requirement of 5 mg/L. Sustained concentrations above this level are considered adequate to support wildlife populations and other desirable water quality conditions. However, the sampling was conducted after the ideal period for catching worst-case DO conditions (5:00-8:00 a.m.). Early-morning sample is needed to assess the status of water quality at this site.

Three of seven DO measurements recorded at this site were below 75% saturation, which suggests that the standard may not have been met. An accurate determination of whether the DO standard is met for % saturation is made using multiple measurements of saturation collected per sampling day. Therefore, DO saturation at this location requires further investigation.



**Figure 15. Dissolved Oxygen (DO) Concentration vs. Temperature. Cochecho River at 12-Cch, Strafford County Farm, Dover, NH. VRAP, Year 2000.**

#### 3.5.2.3 pH

The pH at this location, ranging from 6.38 to 7.01, was measured below the state standard range on two of seven monitoring dates. Site conditions are considered along with pH measurements because of the narrative portion of the pH standard. RSA 485-A:8 states that pH of Class B waters *shall be between 6.5 and 8.0, except when due to natural causes*. Wetlands can lower the pH of a river naturally by releasing tannic and humic acids from decaying plant material. If the sampling location is influenced by wetlands or other natural conditions, then the low pH measurements are not considered a violation of water quality standards. It is important to note that the New Hampshire water quality standard for pH is fairly conservative, thus pH levels slightly below the standard are not necessarily harmful to aquatic life. In this case, additional information about factors influencing pH levels is needed.

#### 3.5.2.4 Nutrients

Surface water quality standards for nutrients currently do not exist in the state of New Hampshire. At this time only general statements will be made with regard to nutrients. Data collected at 12-Cch under the DES Ambient River Sampling Program in 1990 show total phosphorus levels ranging from 0.052-0.215 mg/L. This range is similar to that found during the 2000 VRAP sampling effort. Likewise, data collected at 12-Cch under the DES Ambient River Sampling Program in 1990 show nitrate (NO<sub>3</sub>) levels ranging from 0.2-1.05 mg/L, which is similar to the range found during the 2000 VRAP sampling effort.

### 3.5.3 Recommendations

- **Baseline Monitoring:** Volunteers are encouraged to continue baseline monitoring activities at this location to establish a record of water quality during all conditions. VRAP monitoring augments the data collection and river management efforts of DES as well as local decision makers. The more information in the baseline data set, the more will be known about the river's water quality dynamics, or variations.
- ***E. coli*:** Although the river appears to be meeting standards at this location continued *E. coli* sampling at this location is encouraged. *E. coli* can influence recreational and other potential water quality aspects. Therefore it is important to monitor *E. coli*, especially where swimming might be expected.

If possible, collecting at least three samples during a sixty-day period is recommended, and should be coordinated with DES assessment activities. Although any single sample containing more than 406 CTS/100mL is considered an exceedance of water quality standards, a geometric mean (a type of average) of three or more samples, as written in the surface water quality standards, is more descriptive of overall river conditions, and helps to confirm persistence of potential *E. coli* contamination.

- **Dissolved Oxygen:** Although the river appears to be meeting the minimum instantaneous DO concentration requirement (5 mg/L) at this location, baseline

monitoring should continue with special attention to the time of sampling. Volunteers are encouraged to conduct future sampling efforts in the early morning (5:00-8:00 a.m.) to obtain the lowest, or worst-case, DO concentration readings. Sampling within the early morning hours will help alert volunteers and DES to concentrations below the standard.

To determine if oxygen saturation in the river falls below water quality standards, monitoring data must represent worst and best-case scenarios of DO saturation. Arrangements for sampling oxygen saturation in the river more than once per day can be made through VRAP and the Ambient River Sampling Program.

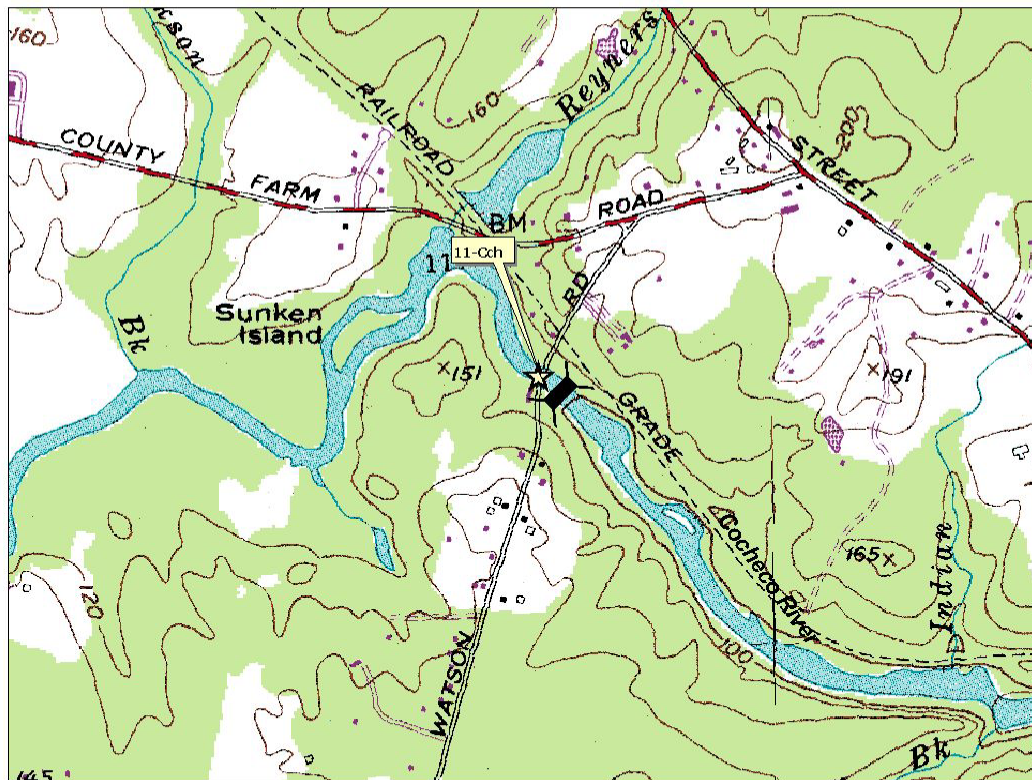
- *pH*: Additional volunteer investigation and sampling is recommended, as specified in the recommendations for 22-Cch.
- *Nutrients*: Volunteer collection of nutrient samples will contribute to the establishment of water quality conditions in the Cocheco River. Volunteers are encouraged to continue collecting samples according to the current schedule and protocol (i.e., two samples for each of the nutrient parameters).

## **3.6 11-Cch: Watson Road, Dover, NH**

### **3.6.1 Site Description**

This site, located approximately 200 feet upstream from the Watson Dam, represents a slow-moving portion of the river (Figure 16). The upland area is primarily rural, with residential development as well. The banks of the river upstream are flanked with trees and shrubs.

## 11-Cch: Watson Rd. Bridge Cocheco River, Dover, NH



0.07 0 0.07 0.14 0.21 0.28 0.35 Miles

### Legend

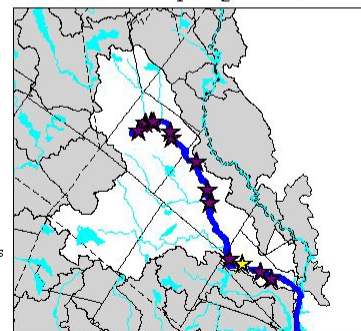
- ☆ Sampling Stations
- ⌵ Dams



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Map Prepared October 24, 2001.

### Cocheco River Watershed VRAP Sampling Stations



(Bright star indicates featured station)

Figure 16. Station location map for 11-Cch, Cocheco River, New Hampshire, VRAP 2000.

### 3.6.2 Results and Discussion

Six water quality measurements were made in the field for each parameter, except for turbidity, which was measured five times. Three samples were collected for laboratory analysis (*E. coli* bacteria and several nutrient species). All samples met the QA/QC requirements. DO and pH data suggest that the Cocheco River at 11-Cch may not meet Class B Water Quality Standards (see Table 6).

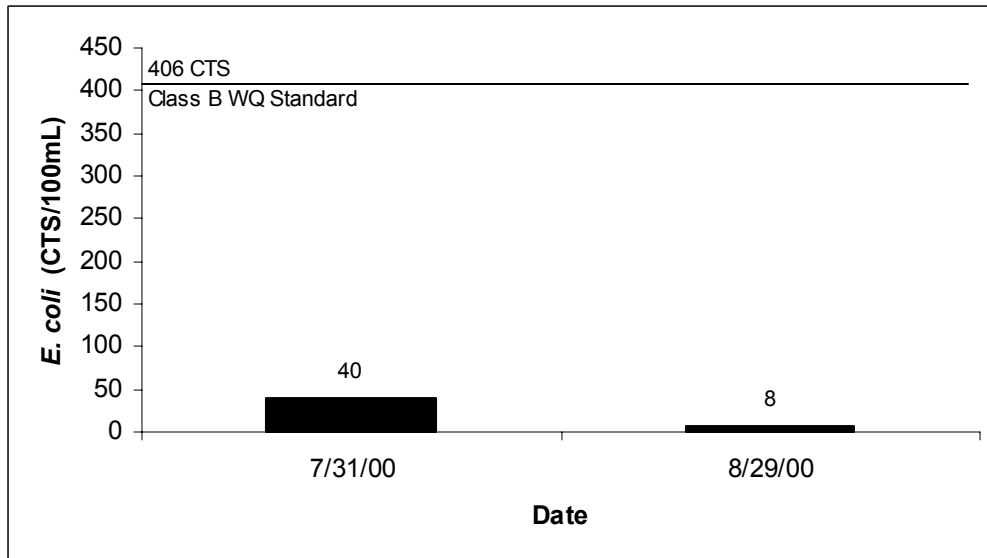
**Table 6. Monitoring Summary: 11-Cch. VRAP, Year 2000.**

Parameter	Samples Collected	Samples Meeting QA/QC Requirements	Acceptable Samples Not Meeting State Criteria	Data Range	Standards
DO (mg/L)	6	6	0	5.29 - 8.2	>5
DO (% sat.)	6	6	3	60.4 - 88.6	>75
pH (std units)	6	6	1	6.41 - 7.23	6.5-8.0
Turbidity (NTUs)	5	5	0	3.8 - 13	<10 NTU above background
Conductivity (µmho/cm)	6	6	0	140 - 190	NA
<i>E. coli</i> CTS/100mL	3	3	0	5 - 40	<406
Total Phosphorus (mg/L)	3	3	NA	0.129 - 0.133	NA
TKN (mg/L)	3	3	NA	0.46 - 1.05	NA
NH <sub>3</sub> (mg/L)	3	3	NA	0.1 - 0.54	NA
NO <sub>3</sub> (mg/L)	3	3	NA	0.53 - 0.94	NA

\*Abbreviated standard values have been used in this table for quick reference. Please see Env-Ws 1700 and RSA 485-A:8 for complete Surface Water Quality Regulations.

#### 3.6.2.1 *E. coli*

Figure 17 shows the *E. coli* counts during summer 2000.

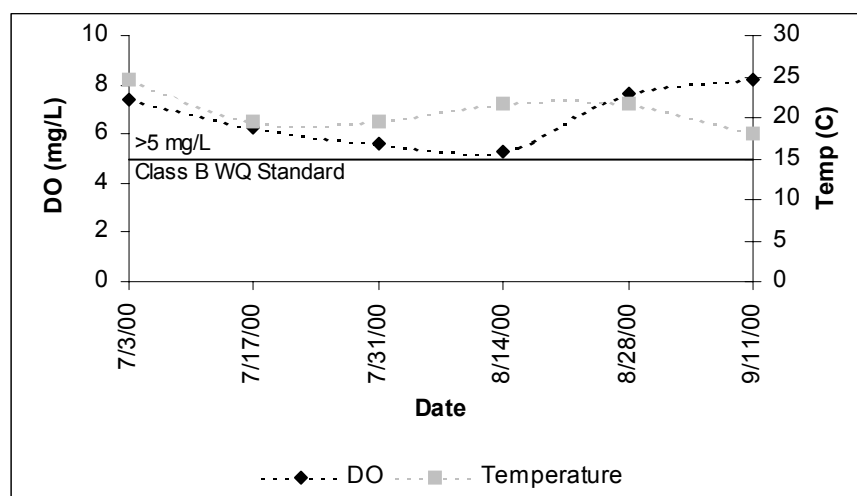


**Figure 17. *E. coli* bacteria counts. Cocheco River at 11-Cch, Watson Road, Dover, NH. VRAP, Year 2000.**

### 3.6.2.2 Dissolved Oxygen

Figure 18 shows dissolved oxygen concentration and water temperature during 2000. Volunteer sampling this year showed DO concentrations above the minimum instantaneous requirement of 5 mg/L. However, the sampling was conducted after the ideal period for catching worst-case DO conditions (5:00-8:00 a.m.). Early morning sample results are needed to assess the status of water quality at this site.

Although the DO concentrations recorded were above 5 mg/L, the saturation was measured below 75% on three occasions. An accurate determination of whether this DO standard is met is made using multiple measurements of saturation collected during per day. Therefore, additional sample results at this location are required.



**Figure 18. Dissolved Oxygen (DO) Concentration vs. Temperature. Cocheco River at 11-Cch, Watson Road, Dover, NH. VRAP, Year 2000.**

#### 3.6.2.3 pH

The pH at this location, ranging from 6.41 to 7.23, was measured below the state standard range on one of six monitoring dates. Site conditions are considered along with pH measurements because of the narrative portion of the pH standard. If the sampling location is influenced by natural conditions, low pH measurements are not considered a violation of water quality standards. RSA 485-A:8 states that pH of Class B waters *shall be between 6.5 and 8.0, except when due to natural causes*. Wetlands can lower the pH of a river naturally by releasing tannic and humic acids from decaying plant material. It is important to note that the New Hampshire water quality standard for pH is fairly conservative, thus pH levels slightly below the standard are not necessarily harmful to aquatic life. In this case, additional information about factors influencing pH levels is needed.

#### 3.6.2.4 Nutrients

Surface water quality standards for nutrients currently do not exist in the state of New Hampshire. At this time only a general comparison will be made with other monitoring data collected at this site. Nutrient data collected at 11-Cch under the DES Ambient River Sampling Program in 1990 show total phosphorus levels ranging from 0.026-0.136 mg/L. This range is similar to that found during the 2000 VRAP sampling effort. Likewise, data collected at 11-Cch under the DES Ambient River Sampling Program in 1990 show nitrate (NO<sub>3</sub>) levels ranging from 0.16-1.7 mg/L, which is a slightly greater range than that found during the 2000 VRAP sampling effort.

### 3.6.3 Recommendations

- *Baseline Monitoring:* Volunteers are encouraged to continue baseline monitoring activities at this location to establish a record of water quality during all conditions. VRAP volunteers are making an increasing amount of water quality data available, in some locations for the very first time. The sampling that has taken place has helped create the recommendations in this report, and VRAP monitoring augments the data collection and river management efforts of DES as well as local decision makers. The more information in the baseline data set, the more will be known about the river's water quality dynamics, or variations.
- *E. coli:* Although the river appears to be meeting standards at this location continued *E. coli* sampling at this location is encouraged. *E. coli* can influence recreational and other potential water quality aspects. Therefore it is important to monitor *E. coli*, especially where swimming might be expected.

If possible, collecting at least three samples during a sixty-day period is recommended, and should be coordinated with DES assessment activities. Although any single sample containing more than 406 CTS/100mL is considered an exceedance of water quality standards, a geometric mean (a type of average) of three or more samples, as written in the surface water quality standards, is more descriptive of overall river conditions, and helps to confirm persistence of potential *E. coli* contamination.

- *Dissolved Oxygen:* Keeping a record of DO will help to determine fluctuations and provide early detection of changes in the river. DO monitoring should continue with special attention to the time of sampling. Volunteers are encouraged to conduct future sampling efforts in the early morning (5:00-8:00 a.m.) to obtain the lowest, or worst-case, DO concentration readings.

To determine if oxygen saturation in the river at this location falls below water quality standards, monitoring data must also represent worst and best-case scenarios of DO saturation. Volunteers working with DES can provide the watershed community with the necessary morning **and** afternoon data points. Arrangements for sampling oxygen saturation in the river more than once per day can be made through VRAP and the Ambient River Sampling Program.

- *pH:* Additional volunteer investigation and sampling is recommended, as specified in the recommendations for 22-Cch.
- *Nutrients:* Volunteer collection of nutrient samples will contribute to the establishment of water quality conditions in the Cocheco River. Volunteers are encouraged to continue collecting samples according to the current schedule and protocol (i.e., two samples for each of the nutrient parameters).

### **3.7 10-Cch: Whittier Street Bridge, Dover, NH**

#### **3.7.1 Site Description**

This site is located just upstream from Whittier Falls, which does not support a dam (Figure 19). The stream bed is primarily rock and gravel, and the riparian areas are forested. However, the upland area downstream from the bridge has residential development. The sample was collected on the upstream side of the bridge over the deepest area, in swift river flow.

## 10-Cch: Whittier St. Bridge Cocheco River, Farmington, NH



### Legend

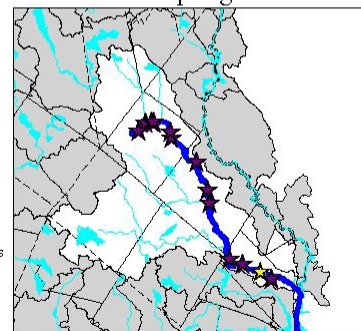
- ★ Sampling Stations
- ⌵ Dams



The coverages presented in this program are under constant revision as new sites or facilities are added. They may not contain all of the potential or existing sites or facilities. The Department is not responsible for the use or interpretation of this information, nor for any inaccuracies.

Map Prepared October 24, 2001.

### Cocheco River Watershed VRAP Sampling Stations



(Bright star indicates featured station)

Figure 19. Station location map for 10-Cch, Cocheco River, New Hampshire, VRAP 2000.

### 3.7.2 Results and Discussion

Six water quality measurements were made in the field for each parameter, and two samples were collected for laboratory analysis (*E. coli* bacteria and several nutrient parameters). All samples met the QA/QC requirements, and DO, pH, turbidity, and *E. coli* results indicate that the Cocheco River at 10-Cch in the year 2000 met the Class B Water Quality Standards (see Table 7).

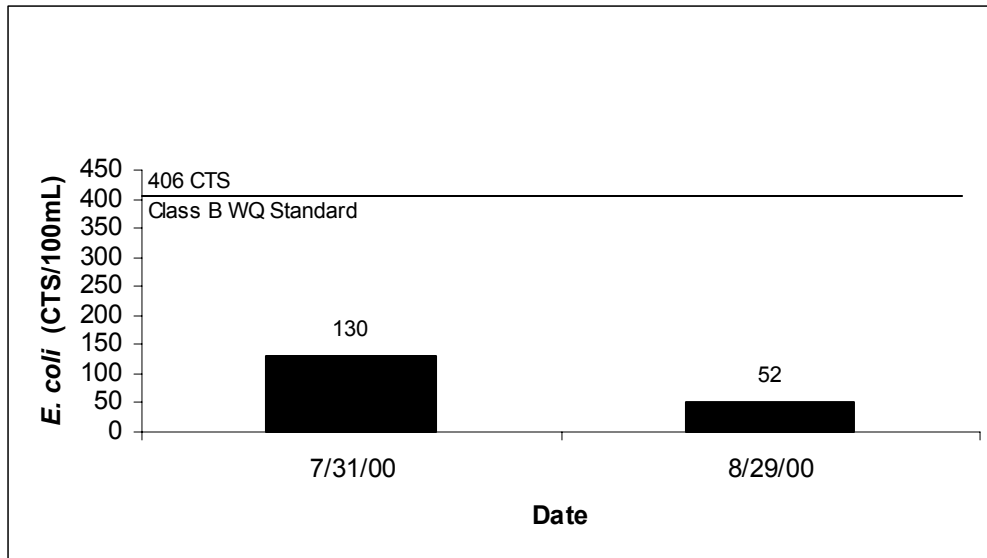
**Table 7. Monitoring Summary: 10-Cch. VRAP, Year 2000.**

Parameter	Samples Collected	Samples Meeting QA/QC Requirements	Acceptable Samples Not Meeting State Criteria	Data Range	Standards
DO (mg/L)	6	6	0	7.01 - 8.67	>5
DO (% sat.)	6	6	0	81.3 - 95.7	>75
pH (std. units)	6	6	0	6.62 - 7.03	6.5-8.0
Turbidity (NTUs)	6	6	0	2.5 - 7	<10 NTU above background
Conductivity (µmho/cm)	6	6	0	141 - 190	NA
<i>E. coli</i> CTS/100mL	2	2	0	52 - 130	<406
Total Phosphorus (mg/L)	2	2	NA	0.101 - 0.126	NA
TKN (mg/L)	2	2	NA	0.38 - 0.84	NA
NH <sub>3</sub> (mg/L)	2	2	NA	0.1 - 0.35	NA
NO <sub>3</sub> (mg/L)	2	2	NA	0.77 - 0.89	NA

\*Abbreviated standard values have been used in this table for quick reference. Please see Env-Ws 1700 and RSA 485-A:8 for complete Surface Water Quality Regulations.

#### 3.7.2.1 *E. coli*

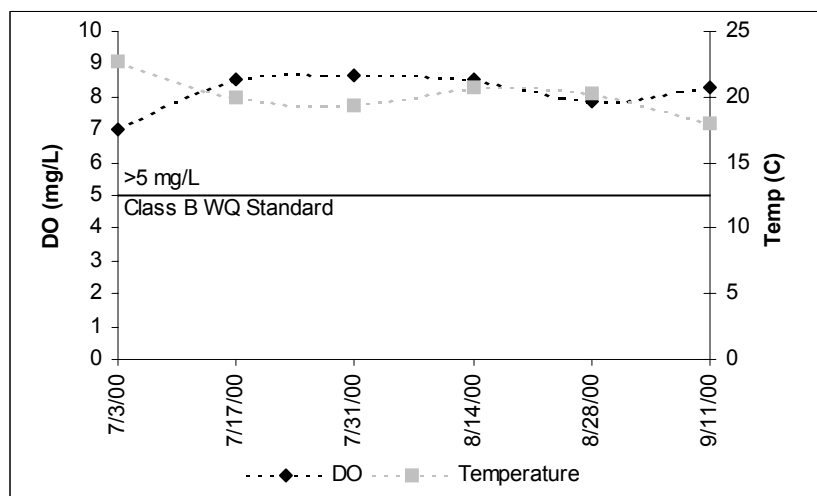
Figure 20 shows the *E. coli* counts during summer 2000.



**Figure 20. *E. coli* bacteria counts. Cocheco River at 10-Cch, Whittier Street bridge, Dover, NH. VRAP, Year 2000.**

### 3.7.2.2 Dissolved Oxygen

Figure 21 shows the DO concentration and water temperature during 2000. The Class B New Hampshire surface water quality standards for DO include a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 % sat. In other words, there are criteria for both concentration and saturation that must be met before the river can be considered as meeting DO standards. Therefore, additional DO saturation data collected at this location are needed.



**Figure 21. Dissolved Oxygen (DO) Concentration vs. Temperature. Cocheco River at 10-Cch, Whittier Street bridge, Dover, NH. VRAP, Year 2000.**

### 3.7.2.3 Nutrients

Data have not been previously collected at this site, so comparisons cannot be made at this time.

### 3.7.3. Recommendations:

- *Baseline Monitoring:* Volunteers are encouraged to continue baseline monitoring activities at this location to establish a record of water quality during all weather conditions. The more information in the baseline data set, the more will be known about the river's water quality dynamics, or variations.
- *E. coli:* Although the river appears to be meeting standards at this location continued *E. coli* sampling at this location is encouraged. *E. coli* can influence recreational and other potential water quality aspects. Therefore it is important to monitor *E. coli*, especially where swimming might be expected.

If possible, collecting at least three samples during a sixty-day period is recommended, and should be coordinated with DES assessment activities. Although any single sample containing more than 406 CTS/100mL is considered an exceedance of water quality standards, a geometric mean (a type of average) of three or more samples, as written in the surface water quality standards, is more descriptive of overall river conditions, and helps to confirm persistence of potential *E. coli* contamination.

- *Dissolved Oxygen:* DO monitoring should continue with special attention to the time of sampling. Volunteers are encouraged to conduct future sampling efforts in the early morning (5:00-8:00 a.m.) to obtain the lowest, or worst-case, DO concentration readings.

To determine if oxygen saturation in the river at this location falls below water quality standards, monitoring data must also represent worst and best-case scenarios of DO saturation. Volunteers working with DES can provide the watershed community with the necessary morning **and** afternoon data points. Arrangements for sampling oxygen saturation in the river more than once per day can be made through VRAP and the Ambient River Sampling Program.

- *Nutrients:* Volunteer collection of nutrient samples will contribute to the establishment of water quality conditions in the Cocheco River. Volunteers are encouraged to continue collecting samples according to the current schedule and protocol (i.e., two samples for each of the nutrient parameters).

## 3.8 07-Cch: Central Avenue Bridge, Dover, NH

### 3.8.1 Site Description

This site is located in the urban center of Dover, approximately 200 feet upstream from Cocheco Falls Dam (Figure 22). The samples were collected on the upstream side of the bridge, midway across the river.

 Sampling Stations  
 Dams



Map Prepared October 24, 2001.

2000  
Cocheco River Water Quality Report

### 3.8.2 Results and Discussion

Six water quality measurements were made in the field for each parameter and two samples were collected for laboratory analysis (*E. coli* bacteria and several nutrient species). All samples met the QA/QC requirements. The pH data indicate that the Cocheco River at 07-Cch in the year 2000 may not meet Class B Water Quality Standards (see Table 8).

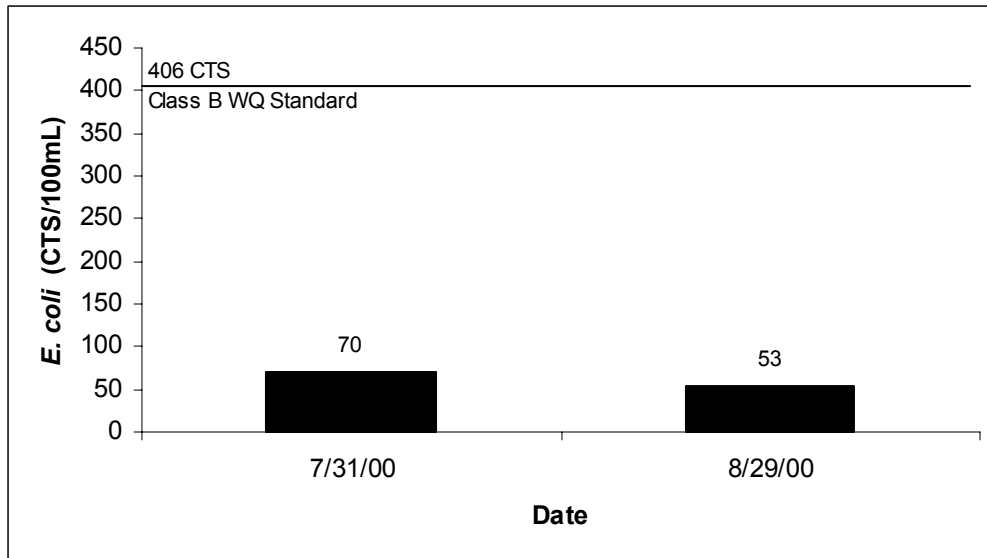
**Table 8. Monitoring Summary: 07-Cch. VRAP, Year 2000.**

Parameter	Samples Collected	Samples Meeting QA/QC Requirements	Acceptable Samples Not Meeting State Criteria	Data Range	Standards
DO (mg/L)	6	6	0	6.89 - 9.07	>5
DO (% sat.)	6	6	0	83.6 - 97.4	>75
pH (std. units)	6	6	3	5.93 - 6.92	6.5-8.0
Turbidity (NTUs)	6	6	0	2.7 - 4.7	<10 NTU above background
Conductivity (µmho/cm)	6	6	0	142 - 190	NA
<i>E. coli</i> CTS/100mL	2	2	0	53 - 70	<406
Total Phosphorus (mg/L)	2	2	NA	0.099 - 0.115	NA
TKN (mg/L)	2	2	NA	0.42 - 0.72	NA
NH <sub>3</sub> (mg/L)	2	2	NA	0.1 - 0.33	NA
NO <sub>3</sub> (mg/L)	2	2	NA	0.67 - 0.69	NA

\*Abbreviated standard values have been used in this table for quick reference. Please see Env-Ws 1700 and RSA 485-A:8 for complete Surface Water Quality Regulations.

#### 3.8.2.1 *E. coli*

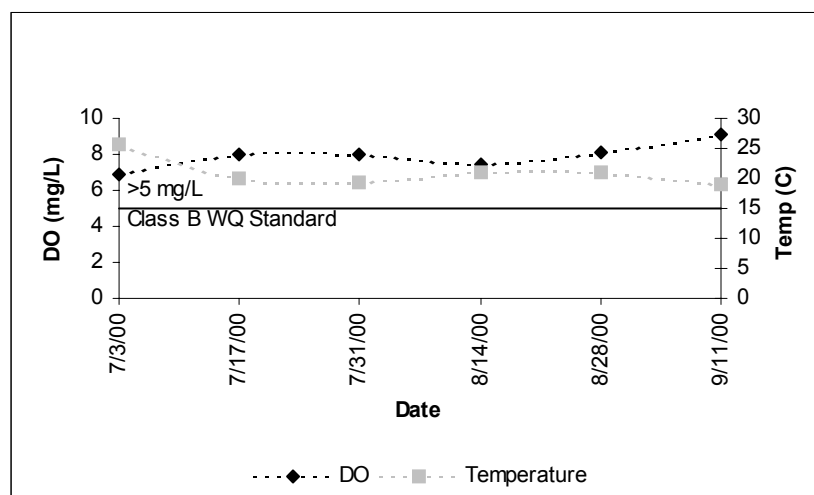
Figure 23 shows the *E. coli* counts during summer 2000.



**Figure 23. *E. coli* bacteria counts. Cocheco River at 07-Cch, Central Avenue bridge, Dover, NH. VRAP, Year 2000.**

### 3.8.2.2 Dissolved Oxygen

Figure 24 shows dissolved oxygen concentration and water temperature during 2000. The Class B New Hampshire surface water quality standards for DO include a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 % sat. In other words, there are criteria for both concentration and saturation that must be met before the river can be considered as meeting DO standards. Therefore, additional DO saturation data collected at this location are needed.



**Figure 24. Dissolved Oxygen (DO) Concentration vs. Temperature. Cocheco River at 07-Cch, Central Avenue bridge, Dover, NH. VRAP, Year 2000.**

#### 3.8.2.3 pH

The pH at this location, ranging from 5.93 to 6.92, was measured below the state standard range on two of seven monitoring dates. If the sampling location is influenced by natural conditions, then low pH measurements are not considered a violation of water quality standards. In this case, additional information about factors influencing pH is needed.

#### 3.8.2.4 Nutrients

Surface water quality standards for nutrients currently do not exist in the state of New Hampshire, and nutrient data are extremely limited at this site. At this time, only general statements will be made with regard to nutrients. A sample collected at 07-Cch by the DES Ambient River Sampling Program in 1993 shows a total phosphorus concentration of 0.007 mg/L. In comparison with the volunteer data this concentration is below the range found during the 2000 VRAP sampling effort, which may indicate increased phosphorus loading at this site. Likewise, data collected at 07-Cch under the DES Ambient River Sampling Program in 1993 show a nitrate (NO<sub>3</sub>) concentration of 0.63 mg/L, which is below the range found during the 2000 VRAP sampling effort. Similar to total phosphorus, additional sampling is necessary.

### 3.8.3 Recommendations

- *Baseline Monitoring:* Volunteers are encouraged to continue baseline monitoring activities at this location to establish a record of water quality during all conditions. The more information in the baseline data set, the more will be known about the river's water quality dynamics, or variations.
- *E. coli:* Although the river appears to be meeting standards at this location continued *E. coli* sampling at this location is encouraged. *E. coli* can influence recreational and other potential water quality aspects. Therefore it is important to monitor *E. coli*, especially where swimming might be expected.

If possible, collecting at least three samples during a sixty-day period is recommended, and should be coordinated with DES assessment activities. Although any single sample containing more than 406 CTS/100mL is considered an exceedance of water quality standards, a geometric mean (a type of average) of three or more samples, as written in the surface water quality standards, is more descriptive of overall river conditions, and helps to confirm persistence of potential *E. coli* contamination.

- *Dissolved Oxygen:* DO monitoring should continue with special attention to the time of sampling. Volunteers are encouraged to conduct future sampling efforts in the early morning (5:00-8:00 a.m.) to obtain the lowest, or worst-case, DO concentration readings.

To determine if oxygen saturation in the river at this location falls below water quality standards, monitoring data must also represent worst and best-case

scenarios of DO saturation. Volunteers working with DES can provide the watershed community with the necessary morning **and** afternoon data points. Arrangements for sampling oxygen saturation in the river more than once per day can be made through VRAP and the Ambient River Sampling Program.

- *pH*: Additional volunteer investigation and sampling is recommended, as specified in the recommendations for 22-Cch.
- *Nutrients*: Volunteer collection of nutrient samples will contribute to the documentation of water quality conditions in the Cocheco River. Volunteers are encouraged to continue collecting samples according to the current schedule and protocol (i.e., two samples for each of the nutrient parameters).

Appendix A:

Coheco River VRAP 2000  
Project Coordinator and Volunteer List

Appendix B:

Cocheco River VRAP 2000  
Monitoring Sites and Preliminary Sites

Appendix C:

Cocheco River VRAP 2000  
Monitoring Results

Appendix D:

VRAP 2000 Parameter Descriptions  
and NH Surface Water Quality Standards

Appendix E:  
VRAP 2000 River Graphs

Appendix F:

VRAP 2000 Field Sampling Protocols